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ABSTRACT

This document is concerned with problems in the education of mathematics teachers. Part 1 gives an overall introduction to the papers included in this volume. Part 2 is concerned with problems of educational reform and provides a survey of the literature on innovation research, discusses some contradictions in the innovation process, and describes prerequisites for a reform of the teaching of mathematics. Part 3 deals with new forms for relating theory to practice in teacher education, describing special instructional methods and competency-based teacher education and discussing a few problems that arise from these approaches. Part 4 looks at general problems of the relationship between theory and practice in teacher training. Part 5 is concerned with mathematics knowledge and the training of teachers of mathematics, and discusses some of the different conceptions of the subject matter and of learning theories. Part 6 offers preliminary conclusions for research and development as well as for content and organization of the training of mathematics teachers. A list of references from European and American sources is included. (Author/DT)

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Tendencies and Problems of the Training of Mathematics Teachers

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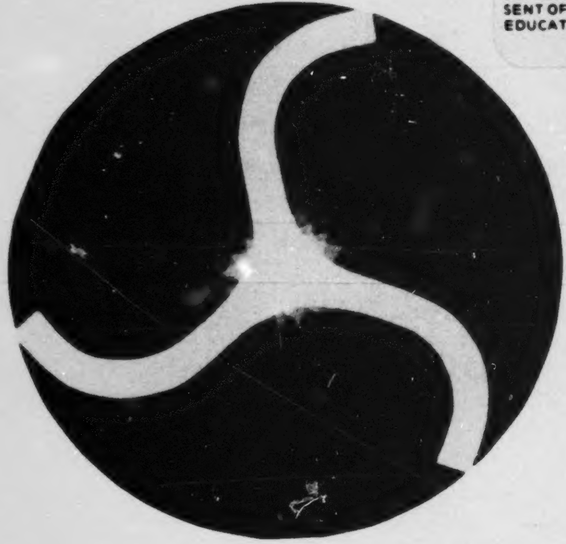

Materials Vol. 1

prepared by the working group 'Mathematiklehrerbildung'

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Tendencies and Problems of the Training of Mathematics Teachers

Materials

working group 'Mathematiklehrerbildung'
Institut für Didaktik der Mathematik

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Our major mistake in mathematics education has been our failure to recognize that we have not possessed the tools needed to do a good job in improving mathematics education, and that in the course of carrying out our normal activities as teachers and as mathematicians we are not likely to be provided with these tools.

E. Begle 1970

Teaching problems must be solved fundamentally.

H. Freudenthal 1974

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1. *Introduction*

Teacher education is a key problem of educational reform. This thesis is basic for a long-term research and development plan by the working-group on "training and further education of mathematics teachers" (Arbeitsgruppe "Mathematiklehrerausbildung und -weiterbildung") at the Institut für Didaktik der Mathematik at Bielefeld. This paper is a preliminary collection of first results achieved in connection with the compilation of a comprehensive documentation on the situation in the training of mathematics teachers. Above all it is intended to serve as an orientation for the seminar on "Tendencies and Problems of the Training of Mathematics Teachers" at Bielefeld from Dec.2 to 6, 1975.

In the last few years the importance of the teacher has increasingly become the focal point in the process of reforming schools and instruction methods. Insight into the causes and the background of the failures of material based curriculum projects, experience gained in the field of school reform, and the intensive discussions about a reform of teacher education at the universities have helped to develop a more refined understanding of the role of the teacher and the importance of teacher education. At the same time central problems in connection with the basic concept of teacher education have not been solved, above all the relation of theory and practice of training in the scientific, paedagogic and socio-scientific field.

In this paper we are concerned with the problems of the education of mathematics teachers in particular. Since the central aspect of a teacher's job, the actual teaching, is a social activity determined essentially by the subject-matter it is an essential prerequisite for all theoretical and practical efforts at reforming teacher education to achieve a clarification of the conception of the subject of instruction and its manifold relations to all aspects of the teacher's job.

On the other hand the problems of the training of mathematics teachers cannot be approached from a subject-related angle only. The significance of teacher training within an innovation strategy with its social, institutional, and methodological implications requires an analysis of the problems at a sufficiently complex level. Didactics, the intermediary agent between theory and practice and between subject-related and social aspects of teaching and learning can only fulfil its task if its view of the problems starts from a sufficiently broad and differentiated basis.

The complex character of mediatorial problems in the sphere of teacher education mentioned above also had its effects on the structure of this paper. The table of contents is proof of the variety of fields that information had to be gathered from. The structure of the paper is caused by the fact that questions and experiences of central importance always run against the division of labour as expressed in the individual academic disciplines or in the distinction between theoretical and practical work. Nevertheless the individual sections can each only deal with some aspects of the problems contained in them.

We hope that this paper, if its characteristics as mentioned above are taken into account, offers possibilities for participation of all the different groups taking an interest in the training of mathematics teachers. This implies also a cooperation across the various, often very heteregeneous theoretical and practical fields of experience. One of the main difficulties here stems from the necessity to develop a common view of the problem. This difficulty is increased by the fact there is a lack of broadness and differentiation in the scientific discussion on teacher education within the disciplines concerned; this also is one of the main conclusions of this paper.

Therefore this paper cannot offer an adequate survey of the problem area that would comprise all aspects involved. It is intended as the starting point for an exchange of experience. A joint formulation of essential questions would already constitute a first decisive step. We hope that this paper and the discussion of it will provide a basis for the development of a continuous and constructive dialogue between representatives of the theoretical and the practical side and the working group. Therefore in connection with and subsequent to this seminar, we will publish a comprehensive documentation, which this material is based on, together with the papers delivered at this seminar and the results of our discussions.

Let us now make a few remarks about the structure and contents of this paper: part 2, following this introduction ("Problems of ecudational reform") offers first a survey of the literature on innovation research, which developed as a reaction to the innovation movements of the last 15 years mainly in the United States. It deals among others with the relation between curriculum development and innovation research and with the importance of the question of problem identification in innovation processes. Following this some contradictions in the innovation process will be discussed, which often are treated in the literature available in the form of false alternatives. Finally some prerequisites for a reform of the teaching of mathematics are described as e.g. the function of teacher organisations and the position of mathematics and natural sciences in the discussion of the concept of general education.

Part 3 ("New forms for relating theory to practice in teacher education") starts from the assumption that the problem of conveying theoretical knowledge with relevance to practice and teaching practical skills on a theoretical background represents the central problem of teacher training. The development in the Federal Republic in this field took a different course from that in the United States: while discussions here concentrated on formulating new concepts for the theoretical aspects of teaching (3.1) in the United States a whole variety of different methods and processes of a pragmatically oriented teaching of theory and practice have been developed. As these developments are largely unknown in the Federal Republic a short description of some special instruction methods (3.2 - 3.6) and of the influential overall concept of "Competency Based Teacher Education"(3.8) will be presented.3.7 deals with a few problems which are of central importance in connection with all these concepts and methods and which refer to the question of how theoretical and practical aspects have to be taken into account in the formulation of an adequate concept of teaching.

Part 4 ("General problems of the relationship between theory and practice in teacher training") systematically combines the individual lines of argument drawn before. Starting from the fact that teacher education and its reform are dependent on prior normative decisions the question of the definition of qualification dimensions and the formulation of training programmes is dealt with. Then the indispensable difference between theory and practice is discussed,a difference and distance which should not be abolished but rather made fruitful. And finally we go into the problem of the authorities engaged in the theoretical and practical side of teacher training from an administrative and a contents-related side.

Part 5 ("Math. Knowledge & the Training of Teachers of Math.") deals with the role of the subject matter in the framework of the teacher's job in a comprehensive way; the arguments therefore very often explicitly or implicitly refer to other parts of the paper. It will be seen from the analysis of generally proposed wrong alternatives in the didactics of the subject that the way the problem of the teacher's function in science and training is approached is characterized by a subdivision into social and contents-related, theoretical and practical aspects. The thesis will be developed that a synthesis of these aspects in teacher training can only be reached by developing an adequate conception of the subject matter, and some of these conceptions will be discussed. Knowledge about the origin, the development, the structure, and the application of knowledge (i.e.'knowledge about knowledge') is of central importance to the clarification of the basic conceptual problems of the teaching of mathematics and the training of mathematics teachers.

Part 6 ("Conclusions") offers preliminary conclusions in the form of theses, which can be drawn from the situation outlined so far. They are conclusions for research and development as well as for contents and organization of the training of mathematics teachers. As statements in the preceeding parts refer to a large extent to experiences in foreign countries, the particular institutional and political framework and the concept of science in Western Germany is taken into account in the formulation of this part.

2. *Problems of Educational Reform*

2.1 *Innovation Research*

The development of innovation research has been closely linked with the speed-up of reforms in the educational sector following the so-called 'sputnik shock' in the United States. A survey of the literature produced in this field leads Havelock to the statement: "The output of relevant studies has been increasing at a very rapid rate over the past decade. At the date which was arbitarily chosen as a starting date for the search of major indices, 1955, a little over 100 studies appeared, a respectable but easily reviewable number, but by 1964 the figure was nearly five times as great" (Havelock 1971, p. 1-19).

For the same period of time Brickel in California finds in his surveys an enormous increase in the rate of innovation, in particular as far as the curriculum is concerned: "The analysis showed that the rate of innovation in the public schools had more than doubled in the fifteen months following the launching of the Soviet Sputnik I in October of 1957. ... Changes had swept not only foreign languages, mathematics, and science - which had led the field by tripling their rate of change - but all other subjects, nonacademics as well as academic, without a single exception" (Brickel in: Miles 1964, p. 495).

A typical example is the curriculum of the PSSC for physics. Development work on it did not start till 1956 and already in 1961 nearly 20% of all secondary schools in the USA used the PSSC-materials.

It is characteristic of this phase of teaching reform to find a widespread belief in methods of innovation as developed in the area of medicine, agriculture and industry for the production and dissemination of hardware products.

This naive faith in a direct technological usability of knowledge for the improvement of the educational system, its contents, methods and forms of organization has been shaken by the poor results of the reform measures borne by it.

"Education, being one of the largest of human enterprises, is certainly experiencing all the pains connected with the increasing demand for improvements and the meagre results of large-scale reform efforts. In most of the economically and technologically advanced western countries, we are in the middle of a switch from 'educational optimism' toward 'educational realism'" (Dalin 1973, p. 24).

This means an important shift of emphasis for innovation research, which becomes quite evident when comparing the topics of two standard books characteristic of these two periods, Mathew B. Miles' "Innovation in Education" (1964) and the OECD-study on "Case Studies of Educational Innovation" (1973). With Miles the emphasis is on extensive curriculum projects, technological innovations, administrative changes and comparatively traditional controversies in teacher education, whereas the OECD-study centres much more on questions about the social aspect of educational reform. Here, complex problems such as the specific role and limits of administrative decisions on the national, regional and local level, the relationship of politics and science, questions of whether/how to involve those affected in curriculum development, the question of side effects etc. play a much greater part. The close link with practical problems which characterises innovation research as applied social science is something one was aware of right from the start: "The current flurry of educational change in America offers an excellent opportunity to study problems of planned change in social systems - an area where our understanding is decidedly less than perfect. Given an increase in understanding, it seems likely that we may be able to manage educational innovation somewhat more skillfully than we have in the past" (Miles in: Miles 1964, p. 2).

What was not realised right from the start, however, was that this link operates on various levels: on the one hand through the concern with somewhat technologically usable knowledge, with strategies, techniques of behaviour, forms of organization etc., on the other through comprehensive social and conceptual ideas of the reform process. If the first phase of curriculum reform was characterised by an optimism due to a technocratic view of science, it is now the second sort of reference to reality which forms the centre of attention.

"Seldom are the implied ideologies analysed; instead, the problems are treated as technical ones. We see this as one of the major problems in the innovation process today" (Dalin 1973, p. 240).

There are no aspects of scientific knowledge concerning fundamental aspects of education as a social institution which do not for their passing-on depend on similar comprehensive views, on the relationship between school and society and on the nature of knowledge itself.

The neglect of the ideological component could be a key to why the results of educational reform as well as of the closely connected concept of innovation research have so far been unsatisfactory.

"There are hundreds of studies of change, many of them concerned with change in education. The weakness of these studies, however, is that few of them are of an empirical nature; few are related to specific educational conditions; little is known of the role which different organizations can play in the process of educational innovation; little - if anything - is known of the interrelationships between different decision-making levels in the educational system as they effect innovation; and few studies have analysed the term 'innovation' itself and the implications of its interpretation for the management of the innovation process" (Dalin 1973, p. 26).

As a definition of the area covered by innovation research Dalin's suggestion seems to us to be the most appropriate one since it summarises the essential aspects discussed into a short formula according to which innovation is "a deliberate attempt to improve practice in relation to certain desired objective" (Dalin 1973, p. 36).

This definition obviously implies the significance of value questions and perspectives of interest for innovation research. Innovation research is always research aiming at the improvement of social processes and is therefore subject to certain criteria as to what is optimal. In addition, the definition implies that innovation follows the available state of knowledge which to an increasing extent has taken a scientific form. In this respect, there is a connection between innovation research and the discussion about the problem of treating everything scientifically, a connection which is also apparent from the title of the so far most comprehensive survey of the existing literature on problems of innovation research, Havelock's "Planning for Innovation through Utilization and Dissemination of Knowledge".

Innovation can refer to rather different aspects of the educational system. Dalin distinguishes in this respect four types of innovation: the first refers to objectives and functions of the school in its broader social and economic context; the second type is mainly concerned with the organization and administration of the educational system; the third is concerned with role definitions and role relationships and the fourth finally centres on changes in the curriculum (cf. Dalin 1973, p. 39-41).

One of the great difficulties in controlling innovative processes lies in the fact that the various types have their own adequate forms of organizsation although there is at the same time a close interdependence between them.

In what follows we are above all concerned with the fourth type because this is particularly relevant for the question of the connection between innovation and teacher training and because it is in the field of the curriculum that the problem of a concept of professional autonomy adequate to the innovative process is particularly acute. It is therefore to be hoped that the previously mentioned interdependances too will be approachable from this perspective.

The curriculum for mathematics was one of the most important starting points for the wave of innovations which started in connection with the sputnik shock. It is in this field therefore that alternative strategies of innovation with their practical advantages and disadvantages have found their clearest expression. The first major curriculum projects to be developed in the USA followed in orientation experiences made in the development and dissemination of hardware products. This was not only true of projects based on behaviourist learning psychology and on the hope raised thereby for more efficient teaching, but also of projects centring above all on a reform of the content in the sense of structure based mathematics (cf. Keitel 1975, p. 28 sequ.). The corresponding strategic concept for innovation starts from a careful separation of individual innovative phases. "It posits a user population which can be reached effectively and influenced through a process of 'dissemination', or by dissemination activities of various sorts, provided, however, that the dissemination is preceded by an extensive and complex process of research and development which usually includes the following features: 'basic research', 'applied research', 'development', 'production', and 'packaging'" (Havelock 1971, 11-6). Havelock talks of 5 basic features of this model: "(1) rational sequence,

(2) planning, (3) division of labor, (4) defined audience, and (5) high investment for maximum pay-off, ..." (Havelock 1971, 11-5).

Inasmuch as the expectations of changing the everyday practices of teaching were disappointed and interest shifted onto the pedagogical realization of new curricula and their psychological and social implications (cf. Ch. Keitel 1975, p. 31 seq.) the shortcomings of this concept of innovation strategies became more and more apparent. Criticism pointed out amongst other things that the social and psychological interdependencies decisive for the acceptance or rejection of an innovation by the system concerned were neglected. "In criticism, the Research Development & Diffusion Model can be said to be over-rational, overidealized, excessively research oriented, and inadequately user-oriented ..." (Havelock 1971, 11-7).

The realization of this model therefore led to an incongruity between the rich financial and qualificatory resources of development management and a lack of systematic, differentiated and practice-oriented development of aims and objectives. "While the institutions studied do seem to manage projects fairly well, one cannot automatically assume that they are successful innovative agencies" (Dalin 1973, p. 107).

These problems are well known from other areas of applied social science. "Die Fixierung der Zielfunktion ist vielfach in multivariablen, großen Systemen notwendig durch willkürliche, zufällige und nicht wissenschaftlich begründbare Entscheidungen gekennzeichnet (Beherrschbarkeitsgrad und Erkenntnis sind funktionell gekoppelt). Es entsteht daher ein Widerspruch zwischen den teilweise gut durchgebildeten Methoden der Optimierung (mathematische und kybernetische Verfahren) und dem vorwiegend qualitativen Charakter der Entscheidungsvorbereitung bei der Auswahl der Zielfunktion" (W. Kriesel 1968).

It is in the dissemination phase at the latest that this incongruity becomes apparent. Since they mark the critical point of transition of new products, modes of behaviour and forms of organization into practical use, problems of dissemination are often simultaneously indicators of deficiencies and difficulties in the whole innovative process, although this becomes somewhat clear only in the case of an obvious failure of an innovative attempt. In the context of the reform of mathematics teaching, however, there are above all cases which under the cover of official directives, curriculum decisions and correspondingly labelled materials are presented to the outside world as successfully concluded innovation processes although the realization has little to do with the original intentions. Sarason used for this the formula "The more things change the more they remain the same." - "'the average teacher has a very great capacity for going on doing the same thing under a different name'" (Beeby in: Howson 1970).

In the light of more recent studies on the implementation of curricula it seems necessary to distinguish clearly between the intention to carry out certain suggestions for change and their actual realization and moreover to posit a great number of gradual differentiations in the realization. A further defect of the traditional concept of curriculum development with a view to the objectives is to be seen in the widespread interchange of aims and means and the general tendency of didactic means to become independent of the aims of teaching. "But the intended consequences are rarely stated clearly, if at all, and as a result, a means to a goal becomes the goals itself, or it becomes the misleading criterion for judging change. Thus, we have the new math, but we do not have those changes in how teachers and children relate to each other that are necessary if both are to enjoy persist in, and productively utilize intellectual and interpersonal experience - and if these are not among the intended consequences, then we must conclude that the curriculum reformers have been quite successful in achieving their goal of substituting one set of books for another" (Sarason 1971, p. 48).

As a consequence of the immanent simplification of the dissemination process the research based on this model of innovation developed methodic instruments for the definition of successful innovation processes which missed the decisive question of the practical implementation (cf. Fullan 1972, p. 5 seq.). Only following the growing disenchantment with the practical effects of the reform attempts did appear studies that undertook more thorough analyses of the effect of planned innovations on schools and teaching, i.e. they treated them from the perspective of those who actually had to deal with them. This meant the collection of individual data of observation which can be used as correctives to the declarations and labels of intent. These studies - mainly thorough case studies or summaries of experiences made in field work - by and large cover the whole spectrum of the innovations recommended and taken up in the Anglo-American countries over the last 15 years. "A very subjective but nonetheless general impression of those who gathered and those who studied the date was that some of the highly recommended and publicized innovations of the past decade or so were dimly conceived and, at best, partially implemented in the schools claiming them ..." (J. Goodlad u.a. 1970, p. 72).

If the predominant innovation model of the sixties considered the main problem to consist in overcoming the resistance of the staff to new ideas, methods and materials, there is now a shift of interest to the difficulties arising out of the practical implementation of innovations which cannot be reduced to psychological defence mechanisms of those involved. "... paradoxically the major problem regarding educational change is not so much resistance to change in traditional schools (although this is still a problem) but how to cope with change in innovative schools" (M. Fullan 1972).

From the literature on curriculum development and innovation research one can deduce two main reasons for the deficiencies of curriculum reform as practised so far: on the one hand the separation of curriculum design and curriculum implementation which corresponds to a division between curriculum theory and innovation research; on the other hand the neglect of the organisatory context in which innovations have to come into their own. In his summary of six case studies on the change of the curriculum W.A. Reid comes to the conclusion that it is this gap between curriculum design and curriculum implementation that is above all responsible for the incompatibility of curriculum theory and the experiences teachers gain in teaching processes. "The gaps between theoretical formulations and the conventional wisdom of schools and teachers are, it would seem, more attributable to inadequacies of the former than the lack of sophistication of the latter" (W. Reid 1975). Innovation research tends to discuss the problems of innovation essentially in terms of individual or social-psychological categories. This is closely connected with the isolation of factors determining innovation and with the neglect of the historic nature of the external conditions: "... impact-oriented studies of innovative projects have not produced generalizable findings because they fail to deal with the interaction of the project with its institutional setting" (Howey 1975, p. 7). "Nearly all reports presently in the literature treat conditions as unchanging and implementation as the result of an accumulation of isolated conditions rather than as a result of an interrelated and complex set of forces" (N. Gross et al. 1971, p. 31).

To develop an alternative concept of curriculum innovation it is necessary to start from a concept of curriculum different from the one underlying the "research-development-diffusion"-approach. This would make the original intention of the curriculum as expressed in the materials and their adaptation as reduced or amplified in the act of teaching refer to each other. "... the parts played in decision-making by aims and constraints are difficult to disentangle, and statements of objectives are only one of many devices for guiding discussion, defining decision points and adjudicating between alternatives. The problem has been noted before, but often in terms of a defect to be remedied rather than a reality to be grappled with, or even built upon" (Reid in: Reid/Walker 1975, p. 253/54).

Such a concept of curriculum would have to take into consideration that the curriculum is a social institution determined by static forces tending to preserve the status quo as well as by those fostering change and that the acceptance of new practices implies the abandonment of old ones which as a rule is a rather painful and laborious process. "In other words, studies of stability might tell us a lot more than studies of change" (Reid in: Reid/Walker 1975, p. 247).

A curriculum theory modified accordingly however must necessarily devote much more attention than customary so far to the qualification and disposition for innovation on the part of the teacher and to the organisatory constraints of his activities. After all he is the main agent in the transition of the curriculum from the design phase to the implementation. "There is one thing that distinguishes teaching from all other professions, ... no change in practice, no change in the curriculum has any meaning unless the teacher understands it and accepts it" (C.B. Beeby in: Howson 1970, p. 46).

The qualification of the teacher and his attitude towards teaching reforms are therefore highly significant. Consequently, a representative survey by Havelock and others on innovation in the American school system reveals the following factors as the main barriers to innovation: "The highest rated barrier item was 'confusion among staff about the purpose of the innovation'. Almost as strong were the items 'unwillingness of teachers and other school personnel to change or listen to new ideas', 'shortage of funds allocated for the innovation', and 'staff's lack of precise information about the innovation'" (R.G. Havelock et al. 1973, I, p. 19).

Three out of these four factors refer to the qualification, disposition for innovation and level of information of the teacher. In a careful case study on the implementation of organisatory innovations Gross et al. have singled out the following factors as decisive for the fate of innovations: the initial disposition for innovation on the part of the staff, the clarity in which the aims, contents and methods of the innovation are set out to the staff, the qualification of the staff, the existence of the necessary materials and resources and the compatibility of the innovation with the organisatory arrangements of the school (time-table, class information, grading system etc.). Here, too, four out of five factors refer to the personal qualifications and disposition of the teacher as well as to the organisatory constraints on his activities.

In a critical survey of empirical studies on the practical effectiveness of innovations Fullan comes to the following conclusions: "... virtually every significant change has implications for changes in roles and role relationships; these changes must be part and parcel of the implementation process.
... The dynamics of the process of role change has been entirely misunderstood and neglected. There is little awareness that innovations require unlearning and relearning and create uncertaintly and a concern about competencies to perform these new roles. Consequently, very little preservice preparation is included in plans for change;

but more fundamentally, virtually no time, resources, and other supports are built into learning of new roles in the ongoing system once the change has been initiated. Since these requirements are not understood and taken into account, even innovations that are congruent with user-objectives often fail.

... Consequent(ly) ... new educational ideas and organizational changes that are introduced become empty alternatives inasmuch as they create unrealistic conditions and expectations for user-performance. Structural changes are necessary but not sufficient to bring about significant change.

The most effective solution can probably never come through the introduction of more and more innovations with additional resources (such as better training in new roles) because the existing systemic context of the user effectively prevents the development of these new roles once they are introduced" (Fullan 1972, p. 15).

In all this the most difficult problem seems to be the achievement of changes in the area of teacher/pupil interaction.

Hoetker and Ahlbrandt have pointed out that in spite of an extensive research literature ranging over decades on the necessity of individualised instruction and work in small groups, it is still recitation by the teacher which is the decisive element in teaching - and this on an international scale. Westbury tries to explain this fact as follows: "The interaction between the demands on the classroom and the constraints within it cause it to be a social setting that has only a limited potential for manipulation by teachers. The recitation is a teaching strategy that permits teachers to deal, in at least a minimally satisfactory way, with the tensions that this interaction between demands and constraints creates" (quoted from Reid et al. 1975, p. 250).

Whereas the requirements are relatively well known, rather less is known about the constraints and their interaction with the requirements.

It is still as true as ever that research and development efforts in education reach the teacher above all through written materials and informal contacts. "It is not surprising, then, that materials have exerted far more influence on practice in the teaching ... than has the available research." And this although only one third of the users "had confidence that they (the materials) were based on 'definite scientific proof'" (Miles in: Miles 1964).

The isolation of the teacher from research and development means that information relevant for teaching is received basically through informal contacts which are naturally confined to his professional group and a narrow local area. This fact has not even changed in the United States, in spite of the development of Teacher Centers, of various centres and laboratories for research and development and of comprehensive curriculum development programmes. On the contrary, as recent analyses show the traditional reciprocal mistrust of practicians and scientists has developed more strongly into the direction of forming negative stereotypes of the other side (cf. Baldridge et al. 1974, p. 706).

The resulting distance of the teacher to the institutionalised research and development process is also supported by the results of the Havelock study: "Once again, outside resource groups get very little mention as key factors. University participation receives only six mentions as 'key factors' (under 2%) while state agencies get only five (a little over 1%). Regional labs get only one mention as a key factor (less than $\frac{1}{2}$% of 1%) and private companies get one. We feel that these findings are among the most significant to emerge from our survey, for while they probably underestimate actual utilization of outside resources, they suggest something about the very low visibility of the external resource universe as far as the overwhelming majority of U.S. school districts are concerned" (R.G. Havelock 1973, p. 16). Miles therefore calls the belief in the independance and autonomy of the teacher in his job and in particular in his practical decisions in teaching a protective myth. This myth is not only in contradiction to the above facts but also to the role of the teacher as a functionary in a bureaucratic school organization: "Thus it seems likely that local innovative are restricted by the fact that the teacher's role is actually that of a bureaucratic functionary ... who has little power to initiate system-wide change, but - because of the ideology concerning professionalism alluded to above - trends to resist innovative demands, like most professionals in bureaucratic organizations" (Miles in: Miles 1964, p. 634). The effect of this is also, of course, that innovations on a local level can only to a very limited extent be started by the teacher himself and that levels of educational administration and political decisions exert a much greater influence. Miles summarises this as follows: "... in most cases the initiation for change in an educational system appears to come from outside ... Moving now to the local system, it seems very clear that administrators, as authority figures, are crucial in introducing innovations, particularly those which involve structural change" (Miles in: Miles 1964, p. 640/41).

This predominance of the administration is probably even stronger in the more centralised Western European countries. In particular in the Federal Republic where extensive efforts in the sense of the "research-development-diffusion"-concept have only intermittently been made, politic-administrative strategies of educational reform are probably still predominant. It seems correct to suggest that the resulting control of innovation processes through curricula rather increases the problems of implementing innovative intentions as outlined from the Anglo-American literature. This, however, results in a dilemma: on the one hand teachers are neither sufficiently disposed nor qualified nor command a satisfactory social status and a corresponding position in relation to the educational administration; on the other, centralised forms of curriculum development which can make use of this lack of prerequisites for reform activities in the teaching profession to rationalize their strategies have the unpleasant side effect of being exposed to the resistance of teachers to forced uncomprehended innovation, a resistance which then leads to the previously described phenomena of interchange of aims and means, of wrong labels and of wrong integration of innovations in practice.

If, however, centralism no matter whether in the sense of drawing together politic-administrative or scientific competence is in no position to remedy the situation, the dilemma cannot on the other hand be solved by setting the teacher free of all constraints in the hope that adequate formulations of the problem would come up by themselves. This kind of ideology is contradicted by the fact that innovative processes at the school level are to a significant extent initiated from outside and that the decisive contribution of the administration to the initiations of innovative processes at the school level is not to be disregarded. It is furthermore contradicted by the fact that innovations if trying to avoid the problem of the 'side effects' can only be implemented systematically and as processes at the same time. Finally, it does not consider the problem of the scarcity of resources.

The alternative 'central or local curriculum development' is the wrong kind of question: "Successful implementation would mean the ability of the institution to be responsive to centrally or externally developed and/or directed innovations, on the one hand an, at the same time, the ability to develop a creative growth and improvement process within the institution itself" (P. Dalin/M. McLaughlin 1975, p. 20; cf. also Dalin 1973, p. 179).

Educational institutions on a local, regional and national level have to make their individual, specific contributions. The central difficulty in their communication and co-operation lies in the development of a common view of the problem and of differentiated tasks developed on this basis. The phase of problem identification, however, is one of the poorest in the common innovative concepts and the corresponding practice: "This phase is seldom based on systematic data-collection about needs and priorities in development. Usually problem identification is an ad hoc exercise, seldom based either on careful examination of present needs, or on long-term educational or integrated social planning" (Dalin 1973, p. 107).

The connection with the deficits in the area of evaluation of innovation is obvious. "Since problem identification and the formulation of objectives is weak, evaluation consequently cannot be strong" (Dalin 1973, p. 143).

It is therefore no surprise to find Miles saying: "Yet, judging from the chapters of this book, a near axiomatic statement is this: Educational innovations are almost never evaluated on a systematic basis" (Miles 1964, p. 657).

And even ten years of further efforts in educational reform seem to have changed nothing: "Unfortunately, however, systems evaluation is seldom part of the innovation process. We do not know, and most innovators do not know either, if the innovations are really working" (Dalin 1973, p. 232).

It seems that the established methods of evaluation are one of the key factors in the growing estrangement between the practician and research and development institutions. "The people running the programs often see evaluation as an effort to kill projects that are dearly loved, and which have cost sweat, blood, and tears at the local level. As a consequence, the local people welcome the evaluator as much as they would any other assasin" (M. Scriven, quoted from Baldridge et al. 1974, p. 703). It is at this point that the distance between the perspective of problems and interests of the practician and that of the educational researcher becomes particularly noticeable.

An alternative can only lie in the development of greater competence and readiness for self-evaluation on the part of the practician conceivably supported of course by external resources (cf. Fullan 1972, p. 29). The first requirement for the effectiveness of this approach is an adequate concept of objectives and their identification. On the one hand it is impossible to lay this down once for all, since they are subject to continual modification in the light of the experiences made with their implementation as to the adequacy of content and the organisatory realisability. On the other hand, they cannot refer to an isolated innovation complex or one dimension of the whole process only, if it is true to say that "... the readiness of the users to implement new structures, products and practices is more of a problem than the development of a particular product itself" (Dalin 1973, p. 260).

This aspect is missed by attempts to structure the process of task identification more systematically without fundamentally changing the linear aims-means-relation and the relationship between practicians and development teams. As the concept of aim is inadequately simplified and as the need for down-to-earth operationalizations and the criteria for evaluation very often prestructure the view of the problem and the task formation, more complex aims and latent functions of innovation processes escape notice. On the other hand, nothing is achieved by an eclectic momentary solution as attempted by Havelock in his 'linkage model' which is less advanced than his own realization that to understand the processes of production, dissemination and practical use of knowledge it is necessary to have a theoretical concept of society and of the essential organisatory subsystems that are part of this process.

The difficulty to understand the specific nature of processes of problem identification and definition in large social organizations as opposed to individual beings is not solved. Instead, there is an idealistic concept of the state as the neutral guardian of public interest and the regulator of conflicts.

"All the models presented are in some way or another concerned with how changes come about. But is it possible to treat the how-question separately without considering why changes should come about, and in what direction the changes are intended to bring us?
When we introduce these dimensions we are immediately confronted by a political problem. Models which build on an assumption of neutrality, rationality and consensus about change are, in our view, unrealistic.
This question is directly linked with the question of interest groups" (Dalin 1973, p. 54).

A concept of the process of problem identification to be worked out is apparently faced with contradictory demands: on the one hand it is supposed to follow up the needs of those immediately concerned, on the other hand it is supposed to be systematic. It is supposed to be locally adaptive as well as centrally integrated. It is supposed to incorporate the political conflicts of interest of the problems and yet to remain object-oriented. It is supposed to afford a maximum of control and yet to be sufficiently complex; and finally it is supposed to be scientifically well-founded and yet adaptable to new situations. It is sufficiently clear that much remains open. Still, it may be useful to realize that one-sided solutions as predominant so far mark no progress and that the solution of the difficulty can only lie in the reconciliation of these discrepancies.

As far as the innovative potential of teacher education is concerned it is only realistic to assume that teacher education can really change only the personal qualifications which teachers bring to their tasks, whereas the organisatory framework in which these faculties are supposed to come into their own remains untouched. This fact is all the more important since it cannot be assumed that in the Federal Republic teaching reforms on a larger scale are to be expected in the next few years. It must be taken into consideration that knowledge, faculties and attitudes as developed in initial training tend to get lost in the course of adapting to one's professional activities (cf. Koch 1972). Still one can find important arguments to support the view that within the framework of educational reform higher emphasis should be placed on teacher training as one of the most important institutional places to reconcile the above-mentioned contradictions. Competence and readiness for innovation are not developed by the teacher by re-adapting his qualifications in the wake of concrete changes of methods, contents and forms of organization. If he is to make use of, or even enlarge, the room for decisions which he himself possesses in the framework of reform, then the improvement of his systematic education which alone ensures flexibility in contact with innovations is a conditio sine qua non.

The cooperation between science and practical teaching, one of the decisive prerequisites to effective innovation, is on the part of practical teaching in need of a differentiated internal structure providing the organisatory framework for division of work, communication and cooperation between the practicians. A strategy of reform which tries to start from a change of teacher behaviour in teacher education is faced here with the problem of the isolation of the teacher in his teaching activities. In the Federal Republic there exists at present hardly any organisatory basis to gradually overcome this kind of isolation. The system of in-service training for teachers is not sufficiently developed from the point of view of capacity and organisatory set-up to meet the demands as outlined above. If therefore Eggleston says, as a result of an OECD-conference on new structures of teacher education and teachers' tasks: "Overall it is clear that initial training and in-service programmes are complementary" (OECD 1974, p. 39), this is certainly not applicable to the majority of teachers working under the present conditions in the Federal Republic. However, there is the not unfounded hope that innovation in the field of teacher training will also lead to further qualification and motivation for in-service training which will itself then exert additional pressure towards the institutionalization of appropriate measures.

In spite of all its shortcomings and deficiencies it may be said of the present system of teacher training
- that it represents the most important organisatory link between practical teaching and the sciences relevant for teaching,
- that it forms decisive paradigms of teacher behaviour
- that it has a comparatively differentiated and unified internal structure which could serve as a basis for the specification of problems and generalization of results,
- that in this system the problem of the independance of theoretical and practical perspectives and their reconciliation has to be faced in all its urgency, as is borne out by the widespread complaints about the lack of connections between the first and the second training phase,
- that in this system the representatives of the practical

teaching phase have reached a level of self-organization of content which gives science the chance of fruitful contacts with practical reality and which can be conducive to the dissemination of results achieved so far through multiplicatory effects.

2.2 *Conditions for Reform*

In contrast to the traditions in other countries, e.g. in France, the subject of mathematics at schools of general education in Germany had at all times to struggle for recognition (cf. Th. Wilhelm 1971). A constant indication of the low value attributed by society to the teaching of mathematics and the natural sciences has always been its relatively low share in the schedule of subjects at the secondary schools (Gymnasium): without any significant change mathematics has accounted for approximately 12% of the weekly schedule ever since 1837, and all natural science subjects together for about 6% (cf. Kroebel 1971a). The debate over the importance of the teaching of mathematics and natural science for general education, which continued during this long period of time with essentially the same arguments, manifested itself in a variety of ways.

In dispute with the humanities attempts were made to demonstrate that the subjects of mathematics and natural science would meet the requirements of the neo-humanistic concept of a general education. According to the prevailing, purely formal ideas of education, which regarded the formation of intellect and character as something detached from the concrete content and substance of the subjects taught, the learning of mathematics was credited with being able to promote logical thinking, tidiness, diligence, neatness etc. Utilitarian arguments were regarded as inadmissible in the discussion by both sides (Riess 1972; Vietzke 1958; Kroebel 1966).

Confronted with governmental authorities, especially on the occasion of changes in school organization, those advocating the teaching mathematics and natural science emphasized the applicability and the benefits of these subjects in economics and for society, not, however, without a certain feeling of apprehension for offering usefulness as an argument.

After the 'sputnik shock' and the debate about the 'educational catastrophe' in the 1960's the issue of formal education, which had dominated the discussion until then, was pushed into the background and applicability and utility of subject matter were acknowledged as criteria for the syllabi of general education. The teaching of mathematics and natural science was legitimated "by its practical value for technology and the direct applicability of school subjects to the working process in form of knowledge, skills and other virtues" (Riess). Accordingly, the Recommendations of the Ministers of Education (Empfehlungen der ständigen Konferenz der Kultusminister) of 1968 concerning the modernization of the teaching of mathematics no longer contained any of the references to intensifying philosophic considerations as had been the custom in earlier regulations: "Progress in mathematics and the advancement of modern mathematical concepts in science which are of consequence to the economy, the society and the state call for the modernization of mathematics instruction in all schools."

Even those who at this time began to levy criticsm against the technocratic applicability of science recognized the criterion of utility but contrasted this criterion of technological and economic utility with the criterion of "social relevance", whose validity was measured against the attainability of objectives of social learning, such as emancipation. By playing off the instrumental aspects of knowledge against its communicative aspects, the proponents of this course developed hostile tendencies towards the teaching of mathematics and the natural sciences. These academic disciplines once again came under pressure to justify themselves and remained on the defensive since no suitable concept of social relevance could be developed. In this situation the teacher is today even more helpless than he had been in the earlier discussion about educational value, because his training did not prepare him to consider social aspects - he takes a strictly negative attitude or reacts cynically.

This last syndrome of hostility toward the teaching of mathematics and natural science further aggravated the social uncertainty of the mathematics teacher in that it adds to the already existing problems of cooperation (with colleagues from other subjects, with educational and social scientists) the problem of having to justify the relevance of the subject matter vis-à-vis the pupils.

The self-organization of teachers in associations, unions etc. decisively determined the attitudes of teachers towards the role of education in social policy. The structure of teachers' organizations is an indication of the development of the teaching profession into a homogeneous professional group. Teacher organizations are an important platform for the generalization of teachers' experiences and hence of consequence for their willingness to accept and generate innovation.

In addition to a separation into more subject-related and more profession-oriented organizations, a differentiation is made between unionized organization and those directly representing professional group interests.

It is characteristic of the educational situation in the Federal Republic of Germany that the largest number of elementary school teachers are unionized in the GEW (union for education and science) while most of the secondary school teachers are members of a professional organization, the 'Philologenverband'. The GEW, which became a member of the DGB (German Federation of Labor) in 1949, began to develop a more and more union-like position as of 1968, a fact characterized by the adoption of collective bargaining rules in their statutes.

Another large teacher organization is the Deutsche Lehrerverband (German Federation of Teachers - DL), a merger of the Philologenverband (Federation of Philologists), the

Realschullehrerverband (Federation of Teachers at Intermediate Schools) and the Verband der Lehrer an Wirtschaftsschulen (Federation of Teachers at Schools of Economics). This federation cooperates with the competing organization of the GEW at primary and secondary modern schools, the Verband Bildung und Erziehung (Federation for Education - VBE). The DL opposes the GEW because of the latter's support for the comprehensive school and for uniform teacher salaries. The GEW and the DL/VBE have approximately the same numerical strength.

In England und Wales the National Union of Teachers (NUT) is the largest teacher organization. It comprises 50% of all teachers (1967). It has members from all types of schools, especially from the Primary Schools (50% of all members teach there) and from the Modern Secondary Schools. Since 1970 the NUT has been a member of the TUC. It supports the Comprehensive Schools (H. Thomas 1975). In contrast, the professional organizations of the "Joint Four" (a merger of the organizations of the Headmasters, Head Mistresses, Assistant Masters and Assistant Mistresses) oppose the Comprehensive Schools and the salary demands of the NUT. Its membership is made up primarily of teachers from the Grammar Schools and the Public Schools.

In France there are no professional teacher organizations; there is a national teachers' union, the Fédération de l'éducation nationale (FEN), which is composed of the various branches representing teachers from different types of schools. While basic agreement prevails within the FEN about the necessity for a reform of the school system (removal of social inequality) there is intensive disagreement between the several branches. The union of elementary school teachers for example holds different views on the reform of primary school from the secondary school teachers.

Among the countries mentioned above there are also differences in the activities of the subject-oriented associations of teachers: The Verein zur Förderung des mathematisch-naturwissenschaftlichen Unterrichts (association for the promotion of the teaching of mathematics and natural sience - MNU) conducts annual seminars on the teaching of mathematics and science, as well as seminars for department heads and publishes corresponding material including a periodical. The French association of mathematics teachers APMEP works on the basis of action programs which are continually re-evaluated according to the progress of teaching reforms. This association was instrumental in founding the IREM (Instituts de recherche sur l'enseignement des mathématiques). The APMEP also publishes a periodical. It has regional sub-divisions which support the work of the IREM and carry out the curriculum work at the schools. In the British Association of Teachers of Mathematics ATM working groups develop materials for teachers. Its 40 local branches as well as 4 publication series attest to its degree of organization.

In contrast to the high degree of organization in the professional organizations - in Britain and the Federal Republic of Germany they comprise roughly 75% of all teachers - organization in the subject-related teacher associations lags considerably behind: of the approximately 98,000 qualified mathematics teachers in the Federal Republic only about 3,500 are members of the MNU.

The APMEP in France, as we have seen, has a considerable influence on teaching reform. In Britain, where the situation is characterized by a much greater autonomy of the teacher in his decisions, the representatives of the teacher associations have more seats than government representatives or scientific experts in nearly all commissions of the School Council, which is the "major curriculum body in England and Wales" (J. Nisbert 1973); they report directly to the associations that delegated them. The Schools Council does not have any executive powers but it has taken decisive steps toward curriculum reform, e.g. in the establishment of Teachers' Centers. Between 1964 and 1970 the School Council supported among other things 368 mathematics projects.

The "Nürnberger Mathematiklehrplan" (Nuremberg mathematics curriculum) of the MNU published in 1965, which was supposed to have initiated a reform of the teaching of mathematics in the Federal Republic of Germany, remained an isolated initiative, since it ran into tough opposition even within MNU. The teacher organizations have no influence on the composition and the activities of the curriculum commissions (cf. Flechsig/Haller 1973).

This comparative outline allows us to draw the following conclusions for the Federal Republic: The structure of teacher organizations is characterized by a split between primary and secondary modern school teachers and grammar school teachers. The position of the teacher organizations within the framework of curriculum reform is particularly unfavorable. The influence of teacher organizations is more limited than in other countries.

In the conception of the sociology of education the overemphasis on organizational matters in the school system correlated with the idea that obstacles for structural change are primarily of a social-psychological nature. Hence analyses concerning the social role of schools in education were limited to a large degree to recording to what extent secondary school teachers were prepared to accept reforms. In addition to that a number of empirical surveys were conducted on the attitude of elementary school teachers, on their job satisfaction and on their position in society. Surprisingly there were no detailed investigations involving teachers of intermediate schools. A comparison of the various findings as to teacher attitudes is rendered difficult due to the methodological defects of many surveys. Leading questions and other drawbacks of the survey techniques used often give rise to doubt as far as the internal validity of the findings is concerned. It is also questionable whether results can be generalized because samples were not sufficiently representative. These facts often contrast in a curious manner with the cost and the meticulousness involved in the analysis of statistical data. Not until the research group "Lehrereinstellungen" (teacher attitudes) began its work in Konstanz was this line of research put on a methodological level which is normal for empirical social science.

Although it must be taken into account that the attitudes of teachers obtained in surveys do not permit a direct inference as to their real behavior, a number of general statements can be made with due caution. Among teacher attitudes concerning the social role of education five relatively universal dimensions may be discerned: 1. attitudes concerning the social position of teachers, 2. political attitudes, 3. disposition to reform, 4. attitudes toward job requirements, 5. attitudes concerning behavior in the classroom. In the following some findings relating to 1. and 3. will be outlined.

To 1. Unanimously the surveys arrive at the conclusion that teachers feel socially insecure irrespective of their type of school. This feeling of insecurity relates to low social prestige, low pay, lack of recognition by government, society, the media, parents. Literature sees this feeling of being brought down in the world in connection with the difficulties teachers have in developing a concept of their own professional acitivities that is characterized by both subject-related specialization and teaching: secondary school teachers as well as elementary school teachers find themselves cought up in the dichotomy of 'specialist versus educator'.

Objective reasons for this feeling of insecurity are to be found in unsolved problems concerning teachers' salaries, disappointment in the fact that promises of reform were not honored, the dependence of educational policy on economic fluctuations, the rising unemployment of teachers which coincides with a shortage of teachers.

To 3. The surveys conducted so far fail to give a precise definition of the term reform and use only general, at times questionable indicators for disposition to reform. They concentrate above all on two factors: attitudes toward the threebranch school system versus attitudes towards the comprehensive school, and the attitudes vis-à-vis the ideology believing in a predetermined intellectual ability of pupils. On this basis, a more accurate assessment of the willingness of teachers to support specific reforms in school can only be speculative.

Despite the increasing demands for participation in decision-making, teachers did not react positively to demands, implicitly stated in a recent survey, for autonomy of the school or the teacher in matters of curricula, for example (Susteck 1975).

3. *New Forms for Relating Theory to Pactice in Teacher Education*

This chapter outlines more recent developments in teacher education. Here we are faced with the difficulty that there are different trends of development in the various countries.

In the Federal Republic where there is traditionally a particularly wide gap between theory and practice, the changes in the field of the 'basic educational sciences' (psychology, sociology, education etc.) predominate the discussion. With empirically oriented positions gaining ground in these sciences after the war a corresponding shift in the content of theoretical training took place, while training methods remaind unchanged. During the 1960s there was an advancement of socio-critical positions within education and related social sciences; the concept of emanicipation began to play a central role in scientific discussions and political controversies concerning the educational system. In connection with that the phenomenon of 'practice shock' ('Praxisschock' e.g. Koch 1971) was rediscovered which describes the influence of the transition from the first (theoretical, university-oriented) to the second (practical, school-oriented) phase of teacher training on the student teachers. The training in theoretical foundations of education was subsequently more related to a broader concept of social sciences, and increasingly focussed on the creation of stable basic orientations which are meant to survive the transition of the students into the new 'socialization environment' of the school.

In 3.1 the theoretical training in educational sciences of German secondary school teachers which accompany the training in their major fields of study are described as an example for such a development. Correspondingly there was an urgent demand for more direct relation to practice within the curricula of the universities (exemplary for the most recent discussions: Blickpunkt Hochschuldidaktik, 32-35), and various ways of immediate contacts with practical fields were tried out (field explorations, inclusion of practical fields outside school, etc.) and the ambivalence of their effects was discovered.

Behind this two-track development - enlarging the contents of and stressing general orientations in the theoretical part on the one hand, experimenting with practical experience as directly as possible on the other - there is often to be found a specific interpretation of university and research personnel: according to this interpretation of university and researchers the universities tend to have more progressive views of education and society, while the school system is seen as having a 'conservative tendency', which means that the existing mediating problems between theory and practice are ascribed to the practical side in a one-sided way (Bürmann 1975).

The realization that one of the reasons for the 'practice shock' phenomenon is to be seen in the fact that most of the graduates lack practical skills especially with reference to teaching has hardly been taken into account in the reform of teacher training in the Federal Republic.

In the United States there are contrasting developments. According to their considerably larger research and innovation capacities and at the same time fewer discussions about teacher training with a focus on social criticism, there has been a tendency to concentrate on developing rather pragmatic methods for a closer connection between theory and practice (3.2 - 3.6). Some of the conceptional problems of these methods are discussed in 3.7. The Competency Based Teacher Education movement (3.8) represents the first comprehensive innovation strategy which attempts to gain better control of the goals of teacher training and to make training institutions as well as students responsible for reading these goals.

The development in the United States is dealt with at relative length because it is largely unknown in the Federal Republic. Besides it concerns certain problems of central importance in the relationship between theory and practice which have so far only insufficiently been tackled in the Federal Republic.

3.1. *The 'Supplementary Studies' in Educational Science*

The 'supplementary studies' (Begleitstudium) have traditionally been part of the first, more theoretically oriented phase of the training of secondary school teachers. While the emphasis in teacher training for primary schools in Western Germany has always been on the pedagogic and educational aspects, the supplementary studies of the secondary school teachers, who concentrate much more on subject-related studies, are intended to introduce them to the pedagogic aspects of their future jobs. These studies include theoretical courses in educational science, sociology, psychology, political science and frequently also in philosophy; occasionally they also include periods of in-practice training. The mainly subject-based preparation is increasingly questioned; and with the increase in the professional character of teaching the necessity grew to develop new concepts for the supplementary studies and to give them higher priority (cf.Bund-Länder-Kommission für Bildungsplanung, 1973, II, A.7; and Deutscher Bildungsrat 1970, Kap.IV).

The most important instrument of Government guidance for the first cycle of teacher training, which is carried out at largely autonomous universities, are the official examination requirements for the 'First State Examination' (Erstes Staatsexamen) which concludes this phase. The examination requirements of the Länder Baden-Württemberg, Hessen, and Bremen can be taken as representative examples of the differences in these regulations from state to state: in the sequence given they attribute increasing importance to the supplementary studies: the weight within the whole examination carried by the grades received in these studies varies between 0 and 50 per cent. Only the examination requirements of Hamburg do not fit into this picture: Here the didactics of the subject is a compulsory part of the supplementary studies.

Requirements for the general examination

1. Baden-Württemberg (examination requirements of 1966, last amendments 1974). The 'general' examination ("allgemeine Prüfung") is voluntary, the results do not count for the final grade. The contents of the studies correspond to the traditional Philosophicum/Pädagogicum, two courses in philosophy or educational science or child psychology are required.

2. Hessen (examination requirements of 1969, last amendments 1974). Examination subject is educational science, on application it can be expanded by philosophy or political science. The grade received constitutes $\frac{1}{8}$ of the final grade in the examination. It is an oral examination held at the end of the studies. The candidate has to prove that he is in a position to "reflect on his fields of specialization on the background of the educational knowledge of the present". In order to be admitted to the final examination the candidate must have had in-practice training for a period of 4 weeks.

3. Bremen (Teacher Training Act and examination requirements of 1974). Examination subject is "educational science including social sciences". The weight of this part within the overall grade varies between $\frac{1}{3}$ and $\frac{1}{2}$ depending on whether the written thesis for the State examination is taken from this field, which is also possible in the case of secondary school teachers. It is an oral examination held at the end of the studies. The requirements are laid down explicitly. They are: knowledge of scientific methods, ability to analyse practical work at school with the help of educational and sociological theory, ability to deal critically with didactical, cross-subject and problem-oriented questions.

The Kasseler Modell - an example of a comprehensive concept of supplementary studies. By decree of 21 March, 1974 the Minister of Education of Hessen has exempted teacher training at the university of Kassel from the above mentioned examination requirements and turned teacher training there into a model project. Within the scope of the Bildungsgesamtplan (regulations for an educational framework) for teacher training (two-cycle training, including in-practice training and subject-related educational studies in the first phase) this model turns the former supplementary studies into the central field of studies ("Kernstudium") determining the contents and organization of the other fields, thus attributing to this field more importance even than in Bremen.

The "Kernstudium" ('core studies') constitutes one third of the total number of courses; the topic for the thesis can be taken from this field. This means that it is of the same importance as the two fields of specialization including the subject-related educational studies.

Since this model project has been in existence only for a short period of time there have been few tangible results so far.

The first characteristic feature of the concept at Kassel is that the "Kernstudium" deliberately is not built up on the traditionally isolated scientific disciplines (educational science, political science, psychology, sociology). What is aimed at is an integration of the individual disciplines and their different aspects taking into account that "the educational work of the teacher is regarded as a social activity".

As a consequence the "Kernstudium" is arranged according to "fields of concentration":
(1) political system and society
(2) socialization/social learning
(3) school and the firm as training institutions of society
(4) curriculum/teaching

Another characteristic feature is the subdivision into three phases of acquiring knowledge in these fields. In a first phase it is tried to "make the student conscious of and remove the individual and class-specific restrictions on experiencing the reality of society and his own self"; in the second phase scientific knowledge and methods are acquired and a critical distance with regard to methods used in institutional procedures is developed; in the third and last phase it is a question of coming to terms with the practical side of teaching from a theoretical-scientific and behaviour-oriented point of view, which is to put the student into a position of being able to "tackle contradictions and conflicts in the sense of changing psycho-social and institutional reference structures in an emancipatory way."

A third characteristic feature is the inclusion of in-practice training at school in the "Kernstudium". Here too, we find a subdivision into phases: explorations of practice in the first phase are followed by teaching jobs parallel to the studies in order to scientifically analyse, plan and carry out teaching tasks in the second phase, and supervised in-practice periods in the form of projects under actual school conditions in the third phase. Especially the second and third phase come under the joint responsibility of social and educational science, science and didactics of the subject.

Trends and problems. An evaluation of the various examination requirements and their revision over the last few years reveals a number of trends showing the pressure towards an increasing professionalization of secondary school teachers:

- increasing share of supplementary studies to a point where they are equal in importance to the subject-related studies;
- restricting the topics in supplementary studies to educational science, extending them at the same time into social sciences;
- a shift in the content of these studies from the history of ideas to a critical evaluation of subjects, knowledge of methods, etc;

- trend towards standardizing supplementary studies through teacher training acts.

A number of important questions, however, remain unsolved:

- There is a lack of concepts for structuring the content of supplementary studies, which at present is more a conglomerate of educational and social sciences.
- What is needed is a constructive content-related relationship between supplementary studies and didactics of the subject and the subject itself.
- Supplementary studies and the second phase must correspond to each other.
- In-practice training at school as part of the supplementary studies must be integrated into the whole course of studies.

3.2 *Human Relations Training in Teacher Education*

Education within the school is an interpersonal process in which the teacher is the central figure of many different interactions. In recent years there has been increasing emphasis on 'social competence' (E. Becker u.a. 1970) as a part of the teacher's professional qualifying profile. The competencies which are normally - not very systematically - attached to this concept often comprise the following: adequate perception of one's own self and others, reflection of one's own role behavior, sensitivity for group processes, competencies in communication and cooperation with others, ability to relate to others, genuineness, empathy, ability to handle conflicts adequately (e.g. Freudenreich et al. 1974, Prose 1973, Bishop 1973).

In Germany many different procedures for improving interpersonel competence are summed up under the collective name of "groups dynamics" (cf. Meyer-Althoff et al. 1975). These procedures have emerged out of different scientific traditions (human relation approach of the sociology of organizations, branches of psychotherapy, antifascist traditions of social psychology around the school of Lewin etc.). Heading 'affective consequences of teaching' Bishop (1973) states a growing urge for introducing elements of human relation training into American teacher education. The reasons given by different authors refer to different realms of action and to different goals within teacher education.

There is the special attempt to improve teaching behavior by a general increase of interpersonal competencies of teachers. Some authors approach the problem by training in special behavioral skills ("socio-integrative style of leadership behavior" Tausch/Tausch 1972) and often relate it to the goal of a "democratization of the teacher-/student-relationship". The last annual sets of the Journal of Applied Behavioral Sciences and its German correspondent journal "Gruppendynamik" contain studies concerning problems and experiences refering to teaching and teacher education. Beside others there are reports of experiments with group dynamics within science and language courses (cf. Rückert 1974, Le Bon 1972).

If the teacher is seen as a socialization agent in his relationship to his students, the demands to his interpersonal competencies are even higher: "Within the process of secondary socialization the teacher is the decisive multiplier. To which extend he is of any help or doing damage to his students, he is seldom aware of" (Mahler 1974, p. 97).

In its present form the teaching profession is more than many other professions running the risk of a 'deformation professionelle'. This is due to its low degree of relief by a professional specialization andto a variety of institutional constraints. Latest since the well-known work of Th. W. Adorno "Tabus über den Lehrerberuf" (1965) it has been pointed out that the teacher is specificly susceptible for the deficiencies of his profession which result from the specific structural problems of his job. "The heavy psychic stress to which the teacher is exposed in his educational activities has been the topic of many publications ..., a detailed psychohygiene of the teaching profession, however, has never been proposed" (Döring 1971, p. 192).

A different reasoning proceeds from the fact that the teacher cannot be qualified for a lifelong professional activity during a preservice-training period of only some years. Therefore it should be relevant the development of learning strategies which refer to his everyday professional life. Learning strategies of this kind are the more efficient, the better the abilities have been developed for self-perception, self-diagnosis and for getting feedback from others (National Institute of

Education 1975, pp. 42).

In connection with efforts to get the notion of the 'innovative teacher' into more precise terms the fact has repeatedly been emphasized that innovative behavior within bureaucratic institutions requires a high degree of readiness to take risks, to tolerate stress and to behave flexibly (Frech 1972, Fittkau 1972). An adequate self-assessment and the clarification of individual uncertainties is a necessary precondition for teachers to get a realistic estimation of their scope of action which in turn is necessary that they can make the best use of it in cooperation with others (Filloux 1972, p. 329). Finally the formation and change of attitudes by which innovative behavior is controlled depends upon affective processes. Some in-service training institutions in the Federal Republic of Germany attempt to relate human relation training for teachers to concepts of political education which intend to help teachers becoming more aware of the institutional and political conditions of their fields of action (cf. Hüppauff 1973).

Human relation training procedures can be located at different points in teacher education:
- it is a well known and often deplored fact that during academic education the cognitive dimensions of learning processes are stressed, while parallel affective processes hampering or promoting learning and leading to isolation or solidarity are officially not taken notice of.
- with forms of skill-training, e.g. microteaching, where it has been seen that ego-involvement is stronger than with the usual academic courses, group dynamic preparatory exercises can have the important function of practising how to give and receive feedback in a way that is sensible and does not endanger self-esteem (Wagner 1975).
- during the first contacts with practice the emotional

strain on the student increases. All studies in this field (cf. Cope 1971) show that the first contacts with practice are not seen by the students as an opportunity of trying out ways of behaviour which are relevant in teaching or testing educational knowledge by applying it. They rather interpret them as situations where they personally have to stand the test, where it is important to gain self-confidence and where adaptation to the future social environment is essential.

The whole complex of psycho-social problems connected with the teaching profession is experienced by the teacher only when he starts teaching on his own. There are a number of studies and analyses, based on experience and practice, and concerned with the difficulties of the probationary year and the ways in which young teachers overcame them; Ryan (1970) can be regarded as exemplary here. The attempts of the young teacher to master the situation in the classroom is compared with 'Robinson Crusoe's fight for survival' (Ryan 1970, p. 169).

Problems of discipline, subliminal struggles for power with the pupils, the danger of perpetual conflicts in the unaccustomed social environment, and general uncertainty and overstrain due to a lack of experience make a permanent learning by trial and error unavoidable (p. 177ff; similar in "Jahrbuch für Junglehrer 1975"). The discrepancy between the institutionally influenced role expectations and the desire of the young teacher to shape his new role, which arises out of his socialization so far, must be solved.

Generally the teacher is prepared for the psycho-social dimension of his profession only in almost primitive way, which is due to the predominance of cognitive aspects in his training. In the academic environment socalled 'personal problems' are pushed off into the private sphere although the restructuring of attitudes and patterns of behaviour is carried out in the context of training and influenced by it. These problems are particularly burning in fields where the character of communication and cooperation processes favours the individualization and isolation of those involved in the scientific process.

If one can regard the studies on the personality structure of students in mathematics and sciences as plausible (summarized in Huber 1974, or Reiß 1975) then processes of self-selection at the beginning of the studies and the subsequent socialization in a sub 'culture' bearing the imprint of the subject lead to an inclination towards certain ways of perception and acting, which need to be subjected to self-reflection precisely for the reason that they are essential for the interpretation and shaping of the professional role but which are completely excluded from the fields dealt with in subject-related studies. The subject-related socialization here runs counter to the development of professionally adequate behaviour tendencies in certain dimensions.

Naturally, the application of group dynamic methods is only one possibility of correction as they have no direct influence either on organizational conditions or concepts of science. As far as the effectiveness of group dynamic methods is concerned no uniform picture can be drawn because of the heterogeneous character of methods and theoretical background and the variety of conditions under which they are applied. Attempts at an evaluation are rarely made apparently because of methodological difficulties and because they would interfere with the methods themselves. The discussion revolves around normative-ideological aspects (cf. Horn 1969, Meyer-Althoff et al. 1975).

While in the United States human-relations methods are gradually gaining ground in teacher education, in West Germany there are hardly any developments worth mentioning. In addition to innovation-barriers that can easily be named, this is also due to the fact that there is a lack of qualified trainers. Group dynamics has established its position in the sphere of private services and thus drains the educational sector of competent personnel.

3.3 *Analysis of Classroom Instruction*

Analysis of classroom instruction comprises methods which describe instructional processes by using uniform criteria that can be operationalized. Such methods have among others been developed in connection with research on teaching under the aim of constructing and empirically founding a "descriptive" theory of instruction, of testing particular hypotheses about the teaching process and about the effectiveness of the teachers behaviour, and finally for finding empirical support for normative concepts of instruction. A survey of the 100 most popular procedures is given by Simon/Boyer (1974).

For practical reasons within teacher education these mothods can only be employed as long as they are extremely simple: categories must be easy to learn, it must be possible to extract the evaluation rapidly and reliably. The interaction analysis system developed by Flanders (1970) has become the most frequently applied in teacher training. According to Frech (1974), this is because it is one of the most simple procedures, because it claims to deal with an essential aspect of teacher behaviour, namely controlling behaviour authority, and because it includes a normative-intentional aspect. In spite of that, the Flanders method is rarely used in West Germany, which may be due to its obvious shortcomings (cf. the criticism by Spanhel 1971, Rumpf 1969, Mies/Vogel 1974). The Flanders method has therefore been changed serval times: refined by the introduction of sub-categories, supplemented by adding complementary, specially cognitive dimensions, facilitated in its evaluation method, and being used not so much for the training of given categories with fixed training objects but rather as a starting point for general processes of category formation. In general, however, it has to be said that all those observation methods which do justice to the complex character of instruction by using more complex category structures cannot be used in teacher training because the training of the observer is too complicated, and this applies particularly to those which adequately integrate subject-matter aspects.

According to Roth/Petrat (1974) procedures other than the Flanders method experimented with in teacher training in West Germany are those described by Winnefeld, Bellack, and Watzlawick as well as a number of pragmatic methods developed partly on an ad hoc basis. Evaluation results vary; there is only little definite information available on the value of training in teaching analysis within teacher education. It is seen as asset among others (Reichling 1975) that methods of classroom observation provide one basis for feedback processes in the training of beginning teachers and that they give rise to intensive discussion about the underlying concepts of teaching. Guidelines for classroom observation written for teachers more often intend to give an incentive for the development of flexible observation instruments rather than advise the usage of standard procedures (cf. Bachmair 1974).

Methods of classroom observation are frequently used in research on teaching to examine the postulated connection between teacher behaviour and student achievement. The deficiencies of these methods, like usage of too abstract terms, lack of complexity of design, insufficient conditions for generalization,false assumptions about the constant character peripheral conditions, incorrect concepts of causality direction lead to research findings which give an inconsistent picture in general (cf. Frech 1974). Theoretical deficits and a high degree of irrelevance for practical purposes in teacher training partly have a common origin, which we will go into later (cf. 3.7).

3.4 *Microteaching*

Microteaching (MT) is a method of situational skill training developed in the early '60s at Stanford University for purposes of teacher training (Allen a.o. 1972). Meanwhile MT has been employed on a broad basis in the United States in pre-service and in-service training, mostly in the form of 'minicourses' for self-instruction; in West Germany at some institutions of teacher training attempts are being made at adapting MT. The minicourses consist of instruction material in the form of films together with manuals for the teacher. In these films a number of up to three teaching skills are characterized and presented in a model teaching situation. The teacher then makes plans for a short teaching unit, carries it out with 5 or 6 of his students, and in the end evaluates a video-record of his own teaching according to given criteria. This step is then repeated with other students. Discussions with colleagues or supervisors are only held at the express wish of the teacher.

The principles of this skill training prepared by discriminating learning and controlled with the help of video feedback ("mirror-TV") have been seen to be practicable in many respects in spite of theoretical deficiencies (e.g. lack of training in analysing conditions for the application of skills). At present about 25 minicourse packages for various age groups, teaching situations, and subject matters are available. Experience with MT seems to be largely positive as far as scope and stability of the change in behaviour, increase in self-confidence and flexibility of behaviour are concerned (cf. Krumm 1972). In West Germany methods guided by MT are applied more flexibly: individual determination of the training objective by the student teacher or teacher, selection of particular skills depending on the supervisors' diagnosis, subject-oriented determination of skills, etc. Some combination with techniques of group dynamics as well as non-directive behaviour of supervisors have proved to be helpful in reducing the fear created by the exposure of the behaviour of the individual concerned. In large areas of teacher training, however, there is a lack of technical equipment nesessary (video equipment, instruction material, model films).

From observations of the course of learning processes in MT, partly backed by empirical findings some authors (cf. Wagner a.o. 1973, Wagner 1975) drew the conclusion that the effect of repeated training or conditioning is less important than the parallel process of cognitive discrimination learning. Thus a concept of microanalysis (instead of MT) was developed, a sort of analysis of teaching with special reference to situational aspects. In microanalysis it is important to learn how to differentiate behaviour in microelements of teaching according to categories. Even here it seems important, however, that the individual behaviour of the trainee himself is subject to analysis. Finally the development of suitable categories (from the socio-emotional or from the cognitive domain for situations of classroom management) presents an as yet unsolved theoretical problem.

3.5 *Protocol Materials*

Protocol materials (PM) are materials for pre-service and in-service training of teachers. The starting point of the PM movement was the influential book "Teachers for the Real World" by B.O. Smith (1969), in which it was stated that teachers lack the capability "to analyse new situations against a firm background of relevant theory" (p. 28). Teaching that is intended to go beyond being a mere craft must be based on theoretical knowledge, and basic elements of theoretical knowledge are concepts. The teacher is to be provided with a repertory of concepts which helps him to make an adequate diagnoses of "events of educational significance" in the case of "instructional situations" as well as "extra classroom situations" (p. 52). The training of behavioural techniques is not aimed at directly. Therefore protocol materials consist mainly of audio-visual material presenting "slices of reality" and serving the purposes of illustrating important theoretical concepts. The fact that the material can be reproduced as well as the fact that it is concept-oriented are regarded as an advantage in comparison to learning in non-reproducable practical situations or with the usual observation methods. The PM movement, promoted by the U.S. Office of Education, has so far developed units in the fields of educational psychology, language, literature, reading, social sciences, and teaching competencies. The production of PM involves a great deal of theoretical problems. While B.O. Smith started from situations relevant in teaching as the central element ("situations-first-strategy") this could not be carried on due to a lack of research in teacher job analyses. Gradually the focal point shifted more and more towards concepts ("concept-first-strategy"). A "Master Coordinate Plan" (B.O. Smith 1973) was developed, which provided a basis for the originally rather uncontrolled selection of concepts from all reference disciplines, a basis which was of a more taxonomic than theoretical nature. The attempts to illustrate an increasing number of concepts with the help of staged 'teaching episodes' made many authors suspicious of a 'concept overkill': the 'real world', for which the teacher was supposed to be trained seemed on the way of degenerating into an artificial world constructed on the basis of the conceptual systems of the various disciplines.

The production of PM involves great expense. The steps in the development - creation of a theoretical reference system, selection of concepts, decision on the media to be used, staging the classroom episodes, and production of technically servicable film material - are all extremely complicated. The development of process can only be coped with by joint efforts of various research and development institutiones.

As the PM movement follows the traditional innovation strategy of research - development - diffusion, dissemination and user-orientation represent the most difficult problems. An adaptation for West Germany would certainly involve great expense for development because of the cultural differences and their effect on the selection of relevant concepts as well as situations. There do exist, however, parallel efforts in West Germany in form of a model experiment set up by the Ministry of Education of Hessen, where audio-visual material for the illustration of innovative teaching behaviour was developed (Analysemodelle 1974). The effectiveness of PM in teacher training has not yet been sufficiently evaluated but all existing evaluation studies report positive and stable improvements in relation to the improvement of interpretation competencies. Occasionally corresponding changes in behaviour without explicit skill training are reported supporting the thesis which also underlies the related concept of micro-analysis stressing the importance of cognitive diagnostic competencies.

3.6 *Models of Teaching*

Models of teaching have always been used in teacher training explicitly or implicitly, in most cases, however, in connection with theoretical training and not in the course of skill-training. Models of teaching as a connecting link between theory and practice are particularly well suited for use in teacher training because of their descriptive as well as prescriptive character (Salzmann 1975). Information, however, about the large number and great variety of existing models is so limited that the resources for the improvement of educational decisions and the stimulation of innovative behaviour that lie in knowledge about alternative models are not used. A remarkable survey by Joyce/Weil (1972) with the title "Models of Teaching" that has gained influence in teacher training in the United States uses as its basis a preliminary selection of 100 teaching models from various fields: "Included were the works of counselors and therapists like Carl Rogers, Erik Erickson, and Abraham

Maslow; learning theorists like Skinner, Ausubel, and Bruner; developmental psychologists like Piaget, Kohlberg, and Hunt; philosophers like Dewey, James, and Broudy. Curriculum development projects in the academic subjects and specialists in group dynamics provided many examples. The patterns of teaching from the great experimental schools like Summerhill made their way onto the general list" (Joyce 1973, p. 390).

According to Joyce's definition a model of teaching consists of "guidelines for designing educational environments through specifying ways of teaching and learning to achieve certain kinds of goals. It includes a rationale of its likely effectiveness and may be accompanied by empirical evidence that it 'works'" (Joyce a.o. 1973, p. 48).

The models were grouped into four large families representing different basic orientations as to the nature of the teaching/learning process:

1. Social Interaction Models. They relate to processes in which reality is socially constituted. Models of this orientation mainly are directed toward the improvement of an individual's ability do relate to others and at developing democratic processes in society.

2. The Information Processing Models. They relate to the ways in which human beings react to outside stimuli, process information, find problems, develop concepts, find solutions to problems, and use symbols. Models of this orientation primarily aim at the development and perfection of such competencies.

3. Personal Models. They emphasize the processes by which an individual constructs and organizes his or her reality. Models of this orientation mainly are intended to help the individual in establishing a productive relation to the environment and in gaining a positive self-assessment.

4. Behaviour Modification Models have evolved from attempts to develop efficient systems for sequencing learning and

shaping behaviour by manipulating reinforcement.

Starting from this classification a programme for teacher training was developed at Columbia University, New York (Joyce a.o. 1973): "A design for teacher education has been made around the concept of providing teacher trainees with the theoretical understanding of the major models of teaching and the clinical competence to employ them in the classroom" (p. 47).

The training programme assigns to each student, independent of his major field, the task to familiarize himself with three models from different model groups in the following stages: Stage 1 constitutes an exploration of the theory of the model, stage 2 demonstrates the model using audio-visual material, stage 3 involves peer teaching, stage 4 is microteaching practice with small groups of students and stage 5 consists of application in a normal classroom situation. Parallel to this work with the three models various teaching skills are trained which have proved to be useful if mastered in advance. At present three skills form the bulk of the component: structuring, modulating, cognitive level and focusing. Other essential elements of the programme are feedback-processes, continuous increase of the share of the practical part, and subject-related educational seminars to relate the models to the subject contents.

The smaller studies on the quality of this training programme carried out so far prove that students can acquire the basic teaching competencies largely independently from their own preferences and independently from the style of teaching of the adviser; some models, however, are apparently more difficult to master than others. Experience gained at Columbia University seem to suggest a more detailed examination of the idea of "models of teaching as the care of teacher education" (Joyce a.o. 1973) as a concept for improving the way in which teacher training relates to practice.

3.7 *Theory and Practice and Conceptualization of Teaching*

Any attempt to systematically tie theory and practice closer together in the training of teachers presupposes a conceptualization of what makes up the core of the activity of the teacher: teaching itself. In comparison to the relatively highly developed state of scientifically based theories of learning, there are admittedly many but not in the same sense scientifically based theories of teaching, despite the existence of many diverse research efforts (Feger et al. 1970). The reasons for this may be attributed to different sources: either to the widespread misconception that provided the existence of an adequate theory of learning, the technicalities of teaching could be derived from the empirical aspects of teaching simply by way of "reflection", or to the fact that teaching processes are structurally more complex than learning processes and thus lend themselves less to theoretical or empirical analysis. What is specific about teaching is its intentionality: Teaching is an activity which aims at producing learning. Any theory of education therefore presupposes a concept of learning and cognition, and beyond that calls for ideas on the mechanisms via which the teaching/learning process achieves or should achieve a formation of the learner through interactional channels.

Finally it is of the greatest importance for the conceptualization of the teaching process that the type of learning which is addressed within the framework of teacher education takes place in a social institution specially designed for learning purposes, namely the school. This establishes important basic conditions for (in-school) teaching/learning processes: where learning becomes the main purposes of permanently regulated social interaction, there arise problems in the selection of objectives and contents, problems of control of largely asymmetric interaction between teacher and pupil, problems of discipline (for the purpose of main-training topic-centered communication), and problems of motivation: the institutionalization of learning processes creates secondary motivation, whose development cannot be dispensed with, while at the same time deficits in intrinsic motivation are being created by the process itself (Luhmann 1974).

From what has been said so far one can conclude that theories of teaching presuppose - compared with theories of learning - a considerably more complex conceptual framework and at least implicit decisions about a number of normative premises. These premises relate, among other things, to the function of public education, the role relationship between teacher and pupil, and the relationship between an individual and society.

In face of this fact it is not surprising that there is a tremendous amount of difficult-to-compare conceptualizations of the teaching process.

The abundance of aspects contained in the process of teaching makes it necessary for any attempt at grasping this process to reduce this complexity to a pragmatic level. Therefore the term 'model' (didaktisches Modell, model of teaching) has been adopted for the concepts of teaching.

Models of teaching always contain a descriptive as well as a prescriptive aspect: on the one hand they can be used for the purpose of analyzing and explaining processes in the class room, in a research strategy sense as heuristic, theory-forming, prognostic instruments, on the other hand they can be used for the planning, control and evaluation of teaching processes. The attending orientation of objectives in the development of models, which is more explicit than in the development of theories, permits us to be more conscious of the necessary selections and facilitates the regulation of the selection process under given objectives. 'Model of teaching' is a key concept of action-oriented didactics, "because this is the threshold between cognition and action, research and application, theory and practice and vice versa" (Flechsig 1975, p. 2). As "the seam between theory and practice" models of teaching can take up a central position in teacher training (Salzmann 1975); indeed, the modern procedures described under 3.3 to 3.6 are based implicitly or explicitly on 'models'. Basically we can distinguish between three variations of model construction:

1. Models of teaching: These are outlines covering long, complex teaching processes, which most frequently take the form of a plan sequence consisting of learning steps, teaching episodes and situation sequences. In older literature the descriptive term "Unterrichtsgestalt" (e.g. Schwerdt 1933) in used; the terms "teaching strategies" and "didactic action strategy" (Miller et al. 1973) refer to the same thing. Also included in this category are the models mentioned by Joyce/Weil (1972) as well as the models which Blankertz (1969) and Walton (1971) compiled in larger groups of "basic patterns of teaching".
2. Item models: These are models of smaller segments of a teaching process such as teaching episodes, minisituations which are reconstructed conceptually in analogy to the structure of the larger unit. Another term used is "element models" (Salzmann 1975). Examples are "didactic approach", "problem-solving", "punishment". Models of this category are the basis of many variations of skill-training and also frequently the training of diagnostic skills (e.g. micro-analysis).
3. Non-actual models: This refers to selections patterns, which are directed towards longer teaching sequences, which, however, in contrast to models of teaching are not structured chronologically, but apply to the entire sequence of teaching a uniform set of criteria of selected variables. Almost all observation techniques used in research on teaching can be traced back to such non-actual models. To a greater degree than the previously mentioned models do they correspond to the paradigm of empirical research

since they are better suited to the formulation of hypotheses concerning the interconnection between variables. 'Non-actual'models can, however, only in a limited sense be used for the planning and controlling of teaching, since they do not provide any behavioral criteria relevant to individual situations beyond general statements like "this teacher is relatively directive" (Uttendorfer et al. 1974). The absence of the prescriptive and hence evaluative aspect is an indication for the frequently deplored lack of practical relevance in empirical research on teaching, which also may be caused by the application of the wrong type of model.

In conclusion it can be stated that all practically relevant procedures of developing qualification in teachers are implicitly or explicitly based on model constructions. This is also true for didactic behavior itself: "... the intended rationality of an actor requires him to construct a simplified model of the real situation to deal with it. He behaves rationally with respect to this model, and such behavior is not even approximately optimal with respect to the real world" (Simon 1957). It is safe to assume that student teachers have simple subjective models of the reality of teaching, inadequate under certain perspectives, which in the course of their training must be brought to a higher level. It is conceivable that such transformation processes can only be set off against a background of practical experience. The connection between "implicit development of theories, experience of reality and strategies for action of teacher" (Wildt et al. 1975) has not yet been empirically investigated, let alone made applicable for training purposes. In the United States, however, there is a recent trend to empirically analyse the cognitive processing mechanisms of teachers ("clinical information processing") and the condition for their development within the framework of broadly based research programs for teacher education (National Institute of Education 1975). In selective perception and processing of realities *concepts* play an essential part. The importance of the acquisition of central concepts in teacher education has even been turned into the guiding principle of a comprehensive attempt at innovation with the "Protocol Materials Movement". Concepts which refer to teaching on the one hand vary according to the level of abstraction on the other according to their usefulness in the control of cognition and behavior: the more a concept yields the greater its distance from what is directly observable. Similarly Ph. G. Smith (1973, p. 33): "The instructional problem in teacher education is that, typically, the more powerful and useful a concept, the greater the inferential distance". These circumstances can easily lead to the following problematic alternative: empiricism without concepts providing no constructive possibilities of action versus concepts removed from reality without productive relevance for dealing with it. In theoretical learning the acquisition of isolated detailed concepts may cause the student to lose touch with overall strategies for action.

Conversely, more complex concepts may easily be turned into fetishes and thus degenerate into global principles, which will block the perception of the multifaceted reality of teaching. Similar onesidedness can develop during training of practical behavior by isolating unconnected miniskills or by drilling didactic 'attitudes' without paying attention to specific situations. The necessary selections therefore not only refer to aspects and situations of the teaching process but at the same time to the *choice of a suitable level of complexity* among the hierarchies of possible conceptualizations. Such decisions can be made only by considering the entire situational context as it refers to objectives, subjective preconditions, and objective general conditions. Only then can the model be adapted to reality and practical work adapted to the model.

In teacher education it will be not so much a matter of working with fixed levels of complexity for the processes of developing models but rather a question of analysing the respective conditions of adequacy in the relationship between model and situation or theory and practice and of marking them useful for training processes. Flexibility in the choice of a suitable level of theory, however, presupposes the mastery of various levels of abstraction.

The same is true for the relationship between different models of teaching of comparable levels of abstraction. Any theory of teaching contains a host of theoretical and normative implications; therefore the same two models may be complementary as well as contradictory as far as different pragmatic contexts are concerned. Here again the problem lies in the selection of a strategy of teaching (or a combination of strategies) which is adequate to a given situation, which presupposes the mastery or knowledge of various strategies as well as the ability to judge the conditions under which they may be applied. An example for a relatively highly developed theoretical foundation of such conditions of adequacy has been supplied by Hunt (1970), who applies the research findings on the concept of cognitive complexity to the problem of matching teaching strategies to the complexity of the learner.

In teacher education it will above all be essential to improve the quality of the decision making processes of applying subjective model concepts in addition to improving the quality of these concepts themselves. This indicates that the theory-practice problem in teacher education can also be approached via a change in feedback practices: "A striking finding ... is that process feedback - providing feedback on the policies or strategies used to make a decision - is far more effective in modifying the judge's behavior than is outcome feedback - providing the judge with the traditional 'knowledge of results'"

(National Institute of Education 1975, p. 43). The concept of 'lens model' feedback (Hammond et al. 1972), in stimulating reflection on subjective processes of theory formation and decision making would form a corrective for the necessarily individual character of models of teaching.

3.8 *Competency-Based Teacher Education* (CBTE):

CBTE is the most comprehensive reform movement in the educational system of the USA. It is a result in a shifting of the focus of innovation in education. "During the first half of this century, efforts to improve education contered largely upon direct modification of the schools. About 1950 this emphasis changed. While attempts to directly modify the schools continued, a marked increase occurred in expenditures to change the pre- and in-service training of teachers as a way of improving education" (B.O. Smith 1975, p. 102). In innovation research as well it was gradually recognized that the teacher has a major role in educational reform. Thus, after the extensive reform efforts in the field of curriculum development, CBTE became the first comprehensive reform movement in teacher education and at the same time the first attempt to organize the training of teachers entirely from the practical point of view. "In its simplest form a competency based program may be defined as one that specifies the objectives for training of teachers in an explicit form, and then proceeds to hold the prospective teacher accountable for meeting those objectives" (Steffensen 1973, p. V).

The CBTE movement was prepared by developments in the field of research on teaching in which teaching was regarded as a form of behavior and analyzed in its elements, by the results of job analysis or task analysis of the teaching profession as well as by efforts to give the schools a greater right of participation in the training of teachers. The Bureau of Educational Personnel Development of the U.S. Office of Education financed a number of CBTE projects, among others that of the AACTE, the American Association of Colleges for Teacher Education.

According to the official definition of the AACTE a teacher training program is competency-based if it shows the following characteristics:

"1. Competencies (knowledge, skills, behaviors) to be demonstrated by the student are derived from explicit conceptions of teacher roles, stated so as to make possible assessment of a student's behavior in relation to specific competencies, and made public in advance.
2. Criteria to be employed in assessing competencies are based upon, and in harmony with, specific competencies; explicit in stating expected levels of mastery under specified conditions; and made public in advance.
3. Assessment of the student's competency uses his performance as the primary source of evidence; takes into account evidence of the student's knowledge relevant to planning for, analyzing, interpreting, or evaluating situations or behaviors; and strives for objectivity.
4. The student's rate of progress through the program is determined by demonstrated competency rather than by time or course completion.
5. The instructional program is intended to facilitate the development and evaluation of the student's achievement of competencies specified" (Elam 1971, p. 4).

Further characteristics of the CBTE-Programs are the following: Individualization of training, frequent feedback concerning learning achievement, close relationship between training and practical work in the schools, emphasis on the necessity to permanently revise the establishment of training objectives, including in this process the communities, colleges, schools and students.

The CBTE principle itself establishes neither objectives nor methods of teacher training. According to current opinion the 'competencies' include, in addition to the mastery of subject content, diagnostic-conceptual abilities as well as behavioral skills. Accordingly all available procedures which contribute to the training of these skills, such as teaching analysis, microteaching, protocol materials, training in models of teaching etc., can be employed within the framework of CBTE-Programs. The CBTE concept is so wide that there is room even for personality-oriented approaches (Humanistic Approach to Teacher Education, Cooper et al. 1973).

The American scene is alive with discussions and controversies pro and contra CBTE. The most significant objections are the following: A sum of individual competencies does not necessarily make for a competent teacher; behavior can be acquired 'superficially', i.e. without touching or changing basic theoretical and normative assumptions. Trivial behavior is most easily operationalized, hence the danger exists, that more complex cognitive skills and more personality-specific changes will be neglected. Teaching competence does not automatically mean teacher competence: if the teacher is to be regarded as an autonomous, critical, innovative individual, a more process-oriented education is called for instead of a behavior-oriented training: "training in conscious self-monitoring rather than in performance competencies" (Elliott et al. 1975, p. 53).

The important objection is based on the argument that the existing research basis for the identification of relevant behavior competencies is insufficient. In their discussion of the well known summary of the results of research on teacher effectiveness by Rosenshine/Furst (1971), Heath/Nielson (1974) arrive at the following conclusion: "... an analysis of the research on the relation between specific teacher skills and student achievement fails to reveal an empirical basis for CBTE" (p. 463). Similarly B.O. Smith (1975) states: "The missing factor is valid content. ... It is now feasible to develop systematic programs to guarantee that trainees acquire both the concepts and the skills of teaching. Knowledge about the procedures and techniques of training, however, exceed what is known about the effectiveness of teaching skills and the utility of concepts. Knowledge of how to train teachers has outstripped knowledge of what to teach them" (p. 103f).

Considering these obvious weaknesses the impact of CBTE is astounding. Since 1970 15 States in the USA have introduced CBTE by way of legislation or decree, there exist a series of national research, development and coordinating centers, pertinent periodical publications and hundreds of books and "Competency-Catalogues" (Merrow 1975, p. 10).

The most important cause for the widespread and growing acceptance of the CBTE concept in the USA may be characterized by the catch-phrase 'press for accountability'. General dissatisfaction with traditional forms of teacher training, rapidly mounting costs and a growing interest on the part of the communities in the school system gave rise to the demands for a specification of objectives, for control over cost-benefit relations and for establishing responsibility for deficiencies (Good et al. 1975).

The advance of modern management techniques in the field of public administration resulted in attempts to design entire teacher training programs on the basis of systems analysis principles (De Vault et al. 1973). The various teacher organizsations protested against the introduction of competency-oriented teacher evaluation procedures, fearing a tightening of employment conditions at a time of teacher surplus; political objections were raised against the technocratic methods of planning (Dodl 1973, p. 198).

An assessment of the effects of CBTE programs is not possible at the present time, since the effects of more basic organizational and substantive reforms of teacher training can be established only in the long run. On the other hand, the CBTE model does offer the advantage of facilitating the planning of teacher training and hence making it more accessible to empirical analysis as well as unifying the efforts of reform. In this respect CBTE programs can be regarded as "testable hypotheses" and thus contribute to putting the training of teachers on a more solid scientific basis. The concept of CBTE may be assailable concerning the determination of valid goals; its increasing influence in the USA however would be inexplicable, if there did not exist a huge store of procedural techniques and *methods for relating theory to practice* in teacher education which are based profoundly on scientific research and practical experience. At this point the development in the Federal Republic of Germany seems to be considerably retarded.

4. *General Problems of the Relationship between Theory and Practice in Teacher Training*

It is impossible to define the practical field of activity of the teacher without referring to administrative constraints, predominating strategies of development and dissemination in the area of the curriculum, the teachers' view of their own role, and to sociological and political ideas about the place and value of the educational system. There is a widerspread tendency to identify the professional practice of the teacher with actual teaching and to underestimate the relevance of activities related to organisatory questions, contacts to the environment (parents etc.), but also the planning of teaching.

"Experience has shown that the choice of research topics is liable to be restricted to pedagogical and didactic issues, above all on the grounds that these are the most 'useful'. A deliberate effort must be made to break this tendency of isolation and restriction to purely pedagogical questions within the educational system and to expand the topics dealt with to cover the role and tasks of school and education in social developments generally, i.e. economics of education, educational sociology, educational policy, educational change etc." (OECD 1974, p. 70). - "Es gehört inzwischen längst zum Konsensbestand der Bildungspolitiker, die Notwendigekeit berufspraktischer Studien zu betonen. Die Praxisorientierung' des Lehrerstudiums wird dabei allerdings zumeist mit der Ineffektivität der bisherigen Ausbildung begründet und eine stärkere Betonung der zukünftigen Unterrichtspraxis in der ersten Ausbildungsphase gefordert. 'Praxis' und 'Unterrichtstätigkeit' sind dabei häufig identische Begriffe, womit entscheidende Dimensionen möglicher Erfahrung ausgeblendet sind" (E. Becker et al. 1974).

Indeed, the results of innovation research suggest to see the cause of the unsatisfactory state of a theory of teaching in the separation of actual teaching and the other aspects involved in the teaching process. The effects of this separation become apparent in the incongruities between planning processes in the area of the curriculum developed from this reduced view as opposed to real professional practice (cf. Flechsig et al. 1973, p. 60ff). As far as attempts to formulate theories of teaching are made at all, they tend to neglect the particular nature of teaching as a characteristic feature of a social institution and to orient themselves along the problems of interaction between the individual learner and the teacher. Consequently P.H. Hirst incorporates the institutional point of view in his definition of 'what is teaching' only as an eclectic addition after having so far defined 'teaching' exclusively in its orientation onto the individual learner: "But perhaps it would be better simply to recognize that we do use the word teaching both for activities aimed at group learning as well as individual learning" (P.H. Hirst 1974, p. 111). This leads to the parallelism of the notions of teaching and learning as customary in psychological literature. Inasmuch as educational research tends to pursue a psychological approach to its subject this is co-responsible for the neglect of the institutional context of teaching and becomes at the same time practically ineffective. "Zu kurz gerät innerhalb der Reformvorschläge die Reflexion über den Arbeitsplatz des Lehrers, durch dessen Strukturen sein Bewußtsein und sein Verhalten entscheidend bestimmt ... werden" (Synopse zur Neuordnung der Lehrerausbildung 1971, p. 47).

If teacher education is to refer to professional practice then the definition of the concept of practice is highly important because it is inevitably connected with normative prejudgments: whether the teacher is to be educated to preserve the status quo, to implement more or less abstract utopic ideas, to be adaptable to emerging trends in educational politics, to have the capability of taking care of his own interests or with a view to long-term plans in educational reform, in each case there are bound to be differing interests involved in situations like these. When using data for the reform of teacher education as made available by empirical occupation research it is therefore important to realize which model they are based on, because socio-politic questions play an important role. School reform and reform of teacher education are too directly dependent on each other to neglect this aspect: "The reform and continous development of teacher education is directly dependent on reform and developments in the school system and education as a whole. Teacher education can never be autonomous or independent. On the other hand changes in teacher education are not to be viewed merely as a necessary consequence of changes in the school system and the field of education. Teacher education is also a developing motive force which can lead to changes and improvements in the educational system" (OECD 1974, p. 60).

By ignoring this interlinks one easily arrives at a fixation of existing professional practice. There a numerous studies for each of the three areas of recruitment, education and professional situation of teachers, but no attempts have been made so far to make these three central aspects of professional competence of the teacher refer to each other nor to incorporate them systematically in attempts describe teacher education (Thomas 1972, p. 30 seq.).

It is an often overlooked fact that scientific theory is connected with the teacher's activities in two notably different ways: on the one hand scientific knowledge and methods are themselves contents of teaching, on the other the organization of teaching and the processes of mediation that occur in its framework need a scientific basis. The teacher is simultaneously the organizer of immediate social relationships with strong subjective elements and the mediator of predetermined, socially codified norms, patterns of evaluation, and knowledge. To achieve a connection between these elements is more difficult than to emphasize the necessity of it. When therefore Hirst states, "It is as much a logical absurdity to say 'One teaches children not subjects' as it is to say 'One teaches subjects not children'" (Hirst 1974, p. 109), this is certainly convincing, but it forgets the conceptual problems involved in the formulation of a constructive alternative. The integration of the two kinds of theory mentioned can only be expected on the basis of developed processes of theory formation which on their part presuppose differentiated practice. This is particularly true of some subjects, such as mathematics, where in addition differences in method perspectives, models and forms of organization between research in social sciences and in mathematics and science have to be coped with.

One can agree with Griesel's attempt to establish an analogy "between engineering and medicine on the one hand and the didactics of mathematics" (Griesel 1974, p. 118) on the other since it points out that the application orientation of the didactics of a subject constitutes its central point of reference, as long as one keeps an eye on the limits of this analogy resulting from the different relations of the individual sciences to their respective practice. The reform concept of 'project studies' in higher education, too, which does not only try to integrate the subject-oriented and educational parts of a study course but intends to combine this at the same time with the development of a critical relationship to professional practice contains this problem as the crucial and still unsolved question: "Das grundsätzliche didaktische Problem, das die Organisation von Lernprozessen in Projekten lösen muß, die die Projektkriterien des Berufspraxisbezugs, der Ermittlung der gesellschaftlichen Relevanz des behandelten Problems durch die Reflexion auf seinen gesellschaftlichen Zusammenhang und der Interdisziplinarität erfüllen, liegt in der Vermittlung der Aneignung fachwissenschaftlicher Inhalte mit der sozialwissenschaftlichen Untersuchung ihrer gesellschaftlichen Konstituierungs- und Verwendungszusammenhänge" (B. Berndt u.a. 1972, p. 298 seq.). The same problem

is made even more acute by the fact that for sciences relevant to teaching as also for other applied sciences the distance and difference between the theoretical concept, as ever reformulated in view of situations of application, and the practical situation itself is unavoidable and even essential. "Even where the precepts constituting the theory of a task or activity are explicitly formulated, such are the innumerable variations in individual circumstances that there can be no hope of the theory encompassing them all. These variations will require that the precepts be modified. Simply following them uncritically can neither guarantee success nor constitute intelligent practice. The precepts themselves, however, do not prescribe how they are to be modified. ... This means that what precise action in particular circumstances a precept prescribes can only be learnt by practice" (Naish/Hartnett 1975, p. 15).

When demanding that teacher education be more scientific it is easy to miss the point that this cannot just mean to purge practice of its handed-on 'craft wisdom' to be replaced by deductions from theoretical insights, but that the main difficulty consists in enabling communication and reciprocal criticism between theory and essential practical experience to take place and to develop the capability of this reciprocal criticism in a systematic way. If this is not taken into account the result is just the same dilemma between empiricistic situation-orientation and 'concept overkill' which seems to have determined the development of the Protocol Materials movement. The aim is not to abolish the 'inferential distance' as B.O. Smith calls it, but to control and use it for the purposes of practice as well as of theory.

The way out of the ineffectiveness of the relationship between theory and practice under the present conditions of teacher education and educational research is not shown up either by proposing an immediate unity of theory and practice, and especially the personal union of educational researcher and teacher. "This is confusing because while the first claim (without practice there can be no theory) is true, it is only true in the sense that there has to be some practice or other for theory to be possible. But Clark wants to say more than this - namely that it is logically necessary for all theorists to be practitioners. This is an astonishing thesis. The point of all my analogies was that this is not how we normally speak of theory and practice. In other contexts it is usual to regard knowing about something and being good at doing it as two different things, and to treat the theory of the knowing as distinguishable from the theory of the doing" (Earwaker 1975, p. 24). Desirable as personal connections and flexible transitions between the two systems may be, research and school practice as institutions necessarily have their own respective objects and perspectives of reality which persist even against the good intentions of the persons involved and which therefore cannot in principle be dissolved by them.

It is on this level that the so-called 'practice shock' would have to be discussed in order to get beyond the phenomenological discussion of the shifts in the attitudinal dimensions analysed. "Man käme dann zu dem nicht sehr überraschenden Ergebnis, daß die Äußerungsformen und Handlungsweisen derselben Personen im Bezug auf gleiche Fragen oder Aufgaben in unterschiedlichen Situationen jeweils andere sind oder zumindest sein können. In diesem Fall wäre vor allen die Bedeutung der unterschiedlichen sozialen Situationen für das Verhalten und die Einstellungen der Ausgebildeten zu analysieren und zwar auf der Ebene der institutionellen Differenz Universität - Schule, der Ebene der unterschiedlichen formellen Sanktionssysteme, der Aufstiegs- und Selektionskriterien sowie der Mechanismen ihrer Ausübung (und der sie durchsetzenden Mächte und Interessen) und schließlich der Ebene der Differenz zwischen "theoretischen" Situationen und den Zwängen praktischer Handlungssituationen" (Bürmann 1975, p. 28).

It is equally true of the relationship between theoretical concepts and practical school work as of the one between the institutional foundations of teacher education and the schools themselves that the attempt to resolve their differences does not lead any further, but that this difference must be made a necessary and fruitful one. The problem of theory vs. practice can only be solved through internal differentiation on both sides and through the establishment and close co-ordination of levels of mediation. The simple attempt to bridge the established systems of scientific distribution of work and the restrictive conditions of practice e.g. by referring to applicationally relevant problems is bound to fail in the long run since it assumes the division of labour in science and in relation to practice to be solely dictated by certain interests of society and corresponding narrow ideologies of special areas rather than also by organisatory and subject-dependent constraints.

If levels of mediation are to be effective, they must be developed in view of the content as well as of the organisatory side. Owing to the importance of immediate social relationships, of norms and ideologies for learning processes at school, appropriate organisatory levels of mediation in the area of schools and teacher eduacation are particularly difficult to establish. It would hardly be enough to rationalize the aims-means relations: they would also have to encompass the levels of problem identification and formulation and decisions about aims. On the part of practice the main deficit in teacher education is to be seen in the great lack of personal, material and conceptual resources for the training in actual teaching which according to its claim would have to effectuate the mediation from practice to theory. On the part of the university the institutional deficit is apparent in the lack of stable and efficient organisatory agencies able to refer research under the specific aspects of theoretical, practice-related education to school realtiy. Even in the United States where the curriculum wave had given rise to a multitude of mediating institutions with the task of relating research and development to school realtiy this has been rather inconsequential as far as teacher education is concerned: "The studies concluded, that there were very few effective relationships between the R&D network and the personnel training network" (Baldridge et al. 1974, p. 706).

From the content point of view the development of levels of mediation takes various directions, first, in the extension of the topic areas and scientific systems of reference in the training programme (cf. 3.1), second, in changes in the conceptual basis of the sciences involved or, alternatively, in the development of more recent and application-related directions of research, and third, finally, in forms of simulating future practical situations working with reduced complexity and building up the capability to control real situations in systematic sequences (cf. 3.2 to 3.8).

Questions of topic extension are for instance involved in the discussion about the educational component of studies, in particular if its function is seen in the passing-on of qualifications in innovation strategies, which includes knowledge of the organisatory and political framework and constraints of educational reforms, of the interests of society involved, of the possibilities and limitations of procedures for the organization of processes of problem formulation and task identification, of the management of innovative developments and of the effect of immediate interactions and subjective dispositions on innovation processes. If one wants "die Verselbständigung der gesellschaftswissenschaftlichen (innovationsstrategischen) Qualifizierung gegenüber der didaktisch-methodischen zu verhindern, die in der Regel nur zur praktischen Irrelevanz der ersteren führt" (Reck 1974, p. 266), it is necessary to extend accordingly the topic areas of the course components concerned with didactics and methodology.

It is here at the latest that the limits of shifts or extensions of topics become noticeable if they remain unaccompanied by corresponding conceptual transformations. The necessity of these transformations has become apparent for instance in chapter 3.2 in connection with the insufficiency of the observation procedures modelled on the traditional paradigm of the hypothesis-testing empirical social sciences. For the didactics of a subject this necessity is evident from the difficulty in referring sociological and subject-related insights to each other. "Es ist aber unsere These, daß die mangelnde Berücksichtigung des inhaltlichen Aspekte mathematischer Lernprozesse die fruchtbare Aufarbeitung gesellschaftswissenschaftlicher Einsichten genauso behindert, wie umgekehrt ein Ausblenden der psychologischen und sozialen Voraussetzungen solcher Lernprozesse nur zu einer Fetischisierung der Fachinhalte und damit eben nicht zu ihrer Aufarbeitung für die Zwecke des Mathematikunterrichts führt. In der mathematikdidaktischen Literatur arbeiten sich diese beiden extremen Standpunkte oft wechselseitig zu, so sehr sie auf den ersten Blick einander entgegengesetzt zu sein scheinen" (Otte et al. 1974, p. 20).

It seems reasonable to suggest that it is in the conceptual field that there lies one of the decisive bottlenecks in the development of a practically efficient and unrepressive kind of teacher education. This is shown particularly well by radical attempts to overcome the inconsequential and unrelated side by side existence of theory and practice, as for instance in the USA through Protocol Materials and CBTE. If the latter again and again complains about the insufficient research basis for the derivation and identification of competencies of the teacher, the former have difficulties in dissolving the empiricistic fixation of concepts to situations in practice without losing the productive connection with reality.

As experiences in Sweden show, where the relations between teacher education and research on teacher education are unusually intensive and differentiated, conceptual problems mean that difficulties of communication and information turn out to be incomparably more persistent than originally expected. The tendency, too, of attempting to simulate situations of practice in teacher training is in its progress likely to keep meeting conceptual difficulties because of the immense problems of selection it is faced with. For the time being it is here that there are the limits to the exploitation of the potential that lies in the rejection of courses exclusively concerned with cognitive faculties and the development of procedures of behaviour training and the acquisition of 'social competence'.

The establishment of organisatory and content-related levels to mediate between theory and practice in courses leads to a growing awareness of the degree of differentiation of the qualificational profile of the teacher. This includes subject competence, knowledge and faculties to set off learning processes, or the ability to relate actively to the social conditions of his own activities. However, lists of qualificational dimensions as have been set up under different theoretical perspectives amongst others by Händle and Luhmann/Schorr (cf. Luhmann/Schorr 1974, p. 5 seq; Chr. Händle 1972, p. 72 seq.) are only a first step, for the central difficulties lie in the distinguishing of these dimensions from each other and in their interrelationship. As we have seen, both innovation research and curriculum theory are deficient because of their separation which allows important problems to escape unnoticed. As far as the qualificational dimensions are concerned, this split is reflected in the division of content-related and didactic competence and the qualifications which refer to the consideration and change of organisatory and social conditions.

The mediation of the two previously treated different kinds of relationship between theory and practice in teacher education, main difficulty in the development of the didactics of the subject, also encompasses all these qualificational dimensions mentioned. This can be shown e.g. in the relationship between the acquisition of specific contents and the implicit passing-on of general ideas about schools, their social function, their relations to science, production and politics. Inasmuch as subject contents are always connected with a specific selectivity in view of reality and with certain perspectives of changing this reality and inasmuch as contents can only be assimilated in these contexts, they play their part in aim orientation and in the development of general views on which orientations are based. To consciously realize similar contexts and connections demands on the part of the teacher the capability to integrate rather different qualifications, and this integration should be prepared for in teacher education. However, it is here that the conceptual gaps are felt most strongly.

In the context of theory and practice in teacher education a certain amount of sceptical reserve seems justified toward ambitious attempts at an organisatory and content-related integration which either totally ignore the conceptual roots of many organisatory problems, as does the one-cycle model of teacher education, or which, as in 'project studies', underestimate the objective constraints and content deficits detrimental to an integration. "Obviously an advanced integration of studies and teaching practice is doomed to failure. The practice of details and parts before the trainee has acquired a sound general view of his subject, of the subject matter involved and of the potentialities or limitations of the latter as a means to the personal development of the pupils, can easily result in mechanical and rigid teaching behaviour during the practice period. Advanced integration in this sense is also a dubious proposition because the trainee's studies would acquire a short-term objective ganges exclusively according to what was useful for the moment. A constant preoccupation with 'useful' things is liable to result in a fragmentary view of the subject and in a simplification of issues" (OECD 1974, p. 32).

Large-scale integration attempts in the system of teacher education in the Federal Republic additionally give rise to sceptical reserve since the education system of the Federal Republic is particularly characterised by its extreme lack of mediating institutions, and, as is shown by the fate of the recommandation by the 'Bildungsrat' (Educational Council) to establish 'regional educational centres', (Regionale Pädagogische Zentren) nothing is likely to change in this respect in the foreseeable future. The deficits in the areas of curriculum development and educational research have been sufficiently deplored and point towards gaps which have to do with the content aspect of teaching problems. Therefore the question suggests itself whether the failure of correspondingly ambitious attempts at integration as more as more admitted by their representatives (cf. P.M. Müller 1974, for project studies in mathematics cf. Hinrichsen et al. 1973, p. 23) is only to be attributed to the growing hostility of national politics toward educational reforms or perhaps also to the insufficient differentiation and development of the concepts which were to form the basis of this integration.

5. *Mathematical Knowledge and the Training of Teachers of Mathematics*

"There was a time when the statement, 'I teach children not subjects', was music to my ears and a positive indication of a dimension of educational philosophy I highly endorsed. I still feel that way but I must confess that recently I have been somewhat alarmed by what I sense on occasion to be a de-emphasis of solid intellectual achievement. Our movement toward such commendable goals as child-oriented programs, humanistically based curriculums, personalized school experiences and open classroom are not to be denied as worthwhile educational directions. The tragedy is that many regard solid intellectual achievement as the enemy in this quest" (Hagen 1973).

This was written by the American teacher O. Hagen, and the dichotomy deplored in his statement is one of the most important ones out of the many contradictory ideas which seem to govern the discussion of didactic and pedagogical issues and which cause the well-known swing of the pendulum of pedagogic opinions on adequate teaching methods. If therefore one wishes to find a suitable approach to the analysis of the current state of the scientific and didactic aspects of education and to make suggestions for further development without falling back onto those unreconciled positions, one cannot - in addition to the analysis of special problems in teacher training - avoid considering the fundamental problems of the role of the subject matter and the function of the concept of content for the organization and planning of teaching.

However, we do not intend to provide another repetition of the topics which make up the contents of the scientific subject studied as part of teacher education. It is enough to state that the rather numerous descriptions of the course content seem to be in agreement as to their essential points (cf. Bishop 1972). E.G. Begle too is right in pointing out the "relative consistency" of the scientific contents determined by the state of development of the science of mathematics, and the situations is similar at tertiary level: "I am sure that many of our teachers look on our new curricula as a revolution in school mathematics. In a sense this is correct, but it is merely a small aspect of a revolution in mathematics itself which has been going on for a century and a half. This revolution stems from the work of Abel and Galois. ... There are two important observations which now need to be made. The first is that this revolution has been successfully concluded. The second is that no new revolution is clearly in sight. Even if the first stirrings of a new revolution might be taking place in mathematical research, its effects could not appear in the pre-college program for generations. Consequently we can agree on the broad outline of the content of the mathematics curriculum for the schools. This content is well enough known that we need not spell it out here in detail" (Begle 1969).

We do believe, though, that this description uncovers a number of unsolved questions and problems which are in need of a scientific analysis within the framework of the three parameters of society - science - education. This however, would go beyond the scope of our topic in hand.

In what follows we are therefore mainly concerned with the question of which kind of knowledge of the subject matter a teacher must have and which concepts of the content of teaching must be developed to clarify its connections with the various aspects of the teaching process to make it more practically controllable. The significance of this approach for teaching itself and for the teacher's view of his own role becomes immediately obvious when realising that to this very day the relationship between various groups of teachers, notably between Primary and Secondary Modern School teachers on the one hand and

Grammar School teachers on the other, are determined by differences which go back to differing ideas about the significance of the science studied for the teacher's work. Although it is true to say that (a) the difficult and laborious development of the principle of the subject teacher at primary level and that (b) the attempt to provide teachers at secondary level with a more professional educational basis, considering that especially grammar school teachers traditionally saw themselves as representing a scientific subject, have become key problems of teacher training, we believe that our aim of a synthesis of scientific and educational knowledge and insights can only be achieved via an appropriate concept of content.

We start from the hypothesis that all didactic, methodological or pedagogic differences and all the various views on teaching objectives imply differing approaches to the content of cognitive activities and of its development as theory and method. This results in the task of developing a concept of teaching content which provides for an integrated view of the dynamic and systematic, operative and objective nature of knowledge and which as a basis allows the teacher to prestructure the determining role of the subject matter in a pedagogically and psychologically appropriate way.

We can only share the surprise expressed in the following quotation by T.W. Eason on the neglect this aspect has met within the traditional discussion on the reform of teacher training: "It is odd that for so long anyone should have conceived of education studies as specialized along the dimensions of, first the sequential development of children; and then of the four now conventional 'disciplines' (PPHS); yet overlooked what 'schooling' means to ordinary folk - the content of instruction and learning, the intellectual skills and conceptualizations which make up the texture and fabric of the growing and educated mind. Because, when all is said and done, the unifying area, the starting point and touchstone, must be curriculum. It would make a fascinating subject in intellectual history (or the sociology of knowledge) to trace the rise and decline of that indifference to content, that rejection of the notion of preconceived subject-matter, curriculum, which lies (but only just) in the immediate past, and made this omission even conceivable" (Eason 1971, p. 92).

This fact can be explained by the current state of pedagogical and didactic research. There are three respects in which the situation is rather unsatisfactory.

- First, activities in the didactics of mathematics and the development of mathematical curricula have until very recently shown little interest in the theory and practice of teaching and the central figure of the teacher. A brief glance into the literature on the didactics of mathematics is enough to be able to say this: the starting-point even if they are explicitly meant to be training materials are always teaching models derived from learning theories and not from elements of a theory of teaching. Very recently only have there been signs for a change in this respect. "It is now becoming more clearly acknowledged that the teacher's role in curriculum development is central. The teacher's status as a professional must be observed and it is a mark of a professional that he is prepared to make decisions and to accept responsibility for them" (Howson 1974).

- Second, the immensely broad field of 'research on teaching' has in no way taken the problem of content into consideration. Dunkin and Biddle, who are probably right in considering their book the first comprehensive study expressly and exclusively concerned with this aspect of teaching (cf. p. vii), comment accordingly: "Given the importance attached to the intellectual aspects of schooling, one might expect that research on cognitive processes in classroom would be at least as prominent as research on social-emotional characteristics. Such is not the case, however. The 1963 edition of the Handbook of Research on Teaching ... contained chapters on the personality of teachers, the measurement of noncognitive variables in research on teaching, social interaction in the classroom, and the social background of teachers - but none on cognitive aspects of teaching. Indeed, there was only one entry pertinent to this topic in the entire lengthy index of the handbook" (Dunkin/Biddle 1974, p. 232).

Nor have the sociological schools of thought researching into the social nature of the production, organization and dissemination of knowledge been interested in the function of knowledge in the educational system: "The almost total neglect by sociologists of how knowledge is selected, organized and assessed in educational institutions hardly needs documenting" (Young (ed) 1971, p. 19; cf. also Esland 1971, p. 72).

- Third, the lack of a translation of 'research on teaching into research on teaching education' (Cyphert 1972) is a serious shortcoming.

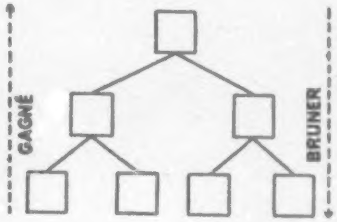
The research described above has had surprisingly little influence on practical teaching which is demonstrable for instance from the mass of empirical data on teaching behaviour as collected by Ahlbrand and Hoetker. "The studies that have been reviewed show a remarkable stability of classroom verbal behaviour patterns over the last half century, despite the fact that each successive generation of educational thinkers, no matter how else they differed, has condemned the rapid-fire, question-answer pattern of instruction ... If the recitation is a poor pedagogical method, as most teacher educators long have believed, why have they not been able to deter teachers from using it?" (cf. Ahlbrand/Hoetker 1969, p. 163).

It seems obvious to attribute this lack of effectiveness to a reductionalistic, merely psychologising view of the problems which misses the institutional and content-determined nature of teaching: "Educational psychologists tend to regard the links between learning and teaching as strong. Reductionalistically viewed teaching simply means the arrangement of external conditions for learning ... derived from psychological knowledge of the learning process. ... But ... we must begin to doubt the claim ... that teaching as a phenomenon can be reduced to a psychological process" (Kallos/Lundgren 1975).

If, however, one turns on the other hand to didactic concepts which keep close to the content in form of a "scientific analysis of the subject matter", one notices a universal mix-up in conceptual and practical difficulties: The "structure of the discipline"-approach is limited by the complexity and complementarity of the theoretical (basic) concepts to be learned (cf. Otte 1974); the problem- or application-orientated approach suddenly discovers that relevant problems are not just factual relationships, but highly complex products of a development which covers social and factual relationships and their interdependance (cf. Mies et al. 1975); the subjective-heuristic approach "process as content" faces the problem of the relationship between method and theory, of strategy and object (cf. H. Weyl 1966, p. 206), and, finally, the exemplary approach which attempts to cover general points by treating specific ones, ends in an empiricistic reductionism which destroys the unity of the process of human cognition and can hardly go beyond the teaching of trivialities.

The centre of the above difficulties is to be seen in a reduced view of the connections of the various aspects of the subject matter and its relationships to science and social reality. This results in the well-known swing of the pendulum of pedagogical methods, the traditions of which A. Rash has followed up in the mathematics books of the 18th, 19th and 20th centuries. She summarises them as follows:"Various aspects of the course content have remained with us through the centuries, but more remarkable is that some methods of presentation have remained unchanged" (A. Rash 1975, p. 434/35). The survival of certain methods due to a periodic movement of pedagogical modes is described as follows: "The current popularity of discovery learning, the inductive method, and the spiral curriculum in education lead us to suspect that the presentations of Ward (1719; the authors) and Davies (about 1850; the authors) were found more satisfactory in that the students understood the theorem better or appreciated its usefulness more if the laborious attempts at multiplying binomials raised to various powers by brute force was tried first" (A. Rash 1975, p. 434/35).

It should be easy to show that the prominent and by now time-honoured dispute about "discovery learning" versus "expository teaching" was (and still is) determined by differing concepts of content. Two positions of learning theory, viz. Bruner's and Gagné's, which had to serve as justifications of this dispute, are being compared in Shulman's summary as follows: "The implications for the sequence of the curriculum growing from these two positions are quite different. For Gagné, the highest level of learning is problem-solving; lower levels involve facts, concepts, principles, and so on. Clearly, for Gagné, the appropriate sequence in learning is in term of the diagram below, from the bottom up. One begins with simple prerequisites and works up, to the complex capability sought."



"For Bruner the same diagram may be appropriate, but the direction of the arrow would be changed. He has the learner begin with problem-solving. Once confronted with a problem, whether embedded in the materials of instruction or directly presented by the teacher, the learner will be led to move back through the hierarchy to form the needed associations, attain the necessary concepts, and, finally, derive the appropriate rules for solving the problem." ... "While for Bruner 'knowing is a process, not a product', for Gagné, 'knowledge is made up of content principles, not heuristic ones'. Thus, though both espouse the acquisition of knowledge as the major objective of education, their definitions of knowledge and knowing are so disparate that the educational objectives sought by each scarcely overlap" (Shulman 1968 and 1970).

In view of this situation it will be comprehensible that the following conceptual ideas and reports on our part will result in a rather preliminary and incomplete picture only.

Of course, the above description of the situation does not imply that the problem as outlined has never been seen and that there are not a number of references to it in the literature. Thus, the psychologist J.A. Easley writes for instance: "We can say ... that the demand will be an increased ability to perceive opportunities for teaching which will depend in turn on developing teachers' conceptions of mathematics and the teaching of mathematics ..." (Easley 1975). Goodlad, too, is aware of the problem although for him it is more or less merely a problem of transforming existing knowledge to the use of the pupils even if in some respects he goes beyond this point of view: "Teachers have found that psychological principles must be translated into implications before they are useful. Similarly, one can become a student of history, chemistry or the fine arts without giving enough thought to the relation of his field to teaching. ... The teacher must be both a student of content organized for preservation and an organizer of content for instruction. ... In large measure, the adequacy is dependent upon the adequacy of the organizing framework - span of control - developed by the teacher. ... A too limited or an erroneous view of content in the teacher's span of control deprives all but the self-directing student of an education" (Goodlad 1959).

A second group (cf. Bernstein 1971, Esland 1971, Kallos/Lundgren 1975, Mies et al. 1975) approach the problem from a fairly comprehensive sociological point of view which emphasises the content and social factors determining the teaching process. The intention aiming at these fundamental relationships is clearly brought out by Kallos and Lundgren (1975) in the following description contrasting their own approach with a merely psychologising one: "The main assumption guiding educational psychologists seems to be that educational problems may be reduced to psychological ones. ... we would suggest a more direct approach. Such an approach should focus on the relations of what is being taught, not to drives or motivational constructs, but to the student's present knowledge and life situation, ... The starting point is the system and not the psychological processes within the individual learner or the teacher."

A central concept in this context is the notion of 'frame'. Bernstein explains: "... frame refers to the degree of control teacher and pupil possess over the selection, organization and pacing of the knowledge transmitted and received in the pedagogical relationship (Bernstein 1971, p. 50). Kallos and Lundgren comment as follows: "In our writings we have used the concept of frame to cover other aspects of the constraints on the pedagogical relationship in the classroom, too. We quite agree, however, that content frames are of prime importance in the establishment of rules operating in the teaching process. The classification and framing of knowledge (contents), using Bernstein's (1971) terms, explicitly reflect the image of man and the very concept of knowledge applied within a particular educational system" (Kallos/Lundgren 1975).

Another concept with a very similar function is given expression by the term 'problems as variables' (cf. Mies et al. 1975).

Finally, Esland (1971) attempts a very instructive view "of teaching and learning, not with but as the organization of knowledge" (p. 73). He shows how the core of many pedagogical and psychological questions is to be found in certain conceptualisations of knowledge. This second group focusses on the relationship between "perspective of teaching" and "nature of knowledge" as the central issue.

Another set of discussions of our problem stems from the area of philosophy of education. Paul H. Hirst (1974) for instance has the following hints on our problem: "Any subject like history or physics or mathematics is based on the use of certain logical principles in terms of which the explanation and theories distinctive of the subject are validated, I refer here to the logic of historical explanations, of scientific explanations, mathematical proofs and so on. ... Any teaching method for the subject must therefore respect the fundamental logical principles without which no understanding of the distinctive form of validity peculiar to this subject is possible. ... The logical grammar involved and the various possibilities for the logical sequence to be used, are matters for determination by an analysis of the subject to be taught, not for empirical investigation. How far these logical features do determine the teaching of a subject, and areas within the subject, can be worked out in detail only in terms of the specific content that is to be taught" (Hirst 1974, p. 130).

Finally, the literature on the didactics of mathematics in a narrower sense contains important references to the teacher's concept of content as a dynamic element in the development of the teaching/learning process. "Most people who use mathematics as a tool in science, industry or commerce find themselves, from time to time, puzzled by doubts as to the nature of the material they are using, such doubts are quickly dismissed if the mathematical techniques bring the required results and if these results make sense in terms of the material world in which we live and work. For teachers, questions concerning the nature of mathematics are likely to arise more frequently and attempts to resolve them must inevitably be more sustained in duration" (Baron 1972, p. 21).

As mathematics is simultaneously an important instrument of other sciences and of social reality and a theory of its own, and as the point of view of application has become increasingly prominent in recent years, discussions on the concept of content tend to centre on a clarification of the relationship between applied and pure mathematics. However, the result is often no more than a plea to emphasize one aspect at the expense of the other. Thus, Ormell describes reactions to his concept (cf. 1972a) as follows: "A number of teachers have remarked to us that this approach seems to emphasize applied mathematics at the expense of pure. In this article the author wants to try to deal as constructively as possible with this criticism of the project's approach, and to throw some light on the role of pure mathematics within the philosophy underlying the approach" (Ormell 1972b).

The central importance of this relationship between pure and applied mathematics for the concept of content and the reform of mathematics teaching is also underlined by Baron (1972): "If we introduce modern mathematics into our schools is it because we are interested in new content and more powerful applications, or is it because we are interested in new methods and new ways of thinking about mathematics? What, in fact, are the aims and purposes of mathematics teaching? Unless we give some careful thought to such questions our teaching is likely to remain at a mediocre level and our day-to-day procedures will be based on tradition, convention and imitation. We will never have the courage to initiate reforms or to break away from the practices of our predecessors" (p. 21/22).

As the existing material taken together shows, there seems to be a growing consensus as to the relevance of the subject contents and the specific significance of the various school subjects for research into cognitive processes and social interaction in class, with a view to optimise practical teaching. "There is a growing literature supporting the notions of subject-matter specificity in the structures of knowledge and forms of learning; it also supports the problem- or case-specificity of processes of judgement and decision-making. Although the 'psychology of school subject' originally enjoyed its greatest popularity in the 20s and 30s, there is a growing sense among educational theorists that our quest for universal subject-independent, theories of learning and instruction has been hampered by ignoring the very real differences among the subject matter areas to be learned" (NIE-panel 1975, p. 28).

To a certain extent this tendency also finds expression in newer concepts and procedures for a more practical orientation of teacher training. In the area of empirical research on teaching, essentially based on indirect models of homogeneous category formation for all phases and nearly any kind of teaching, use is made above all of models of observation and analysis which are content-independant. These develop categories not according to the subject of teaching but rather out of its socio-emotional characteristics. It comes as no surprise here, of course, that the results of these analyses although using identical instruments depend heavily on the subject matter: "Subject being taught exerted massive influence on frequency of occurrence of all the Flanders categories except praise and criticism. The colossal influence of the subject on the nature of classroom interaction is certainly the most striking and important finding ..." (Westbury et al. 1971, p. 127). However, to turn to the "microstructure of the detail" (Spanhel, 1971) as recommended by the critics of content-independant observation procedures merely leads to an increasing complexity of research designs. The only observation procedure specially developed for mathematics teaching (Wright et al. 1961) contains so many variables that for this reason alone it is only suitable for purposes of hypothesis-testing research. As observation procedures of this nature are only suitable for descriptive purposes and not for the planning of teaching behaviour, a stronger incorporation of didactic theory of the subject cannot be expected to overcome their practical ineffectiveness.

As far as models of details are concerned which describe sections of teaching situations and situationally usable skills there are content-independant ones (e.g. "verbal reinforcement") likely to occur in any kind of teaching and others whose frequency varies according to the subject or which in certain subjects do not occur at all. Accordingly, microteaching and microanalysis practise and analyse subject-specific skills and situations as well as subject-independant ones. Becker (1973, p. 22) writes in this context: "Zwar lassen sich viele Lehrer-Verhaltensweisen zumindest kurzzeitig in jedem Unterrichtsfach einsetzen, doch haben einige Teaching Skills für bestimmte Fächer höhere Relevanz." The consequences of this for teacher training are obviously that a combined subject-specific and subject-independant approach to diagnostic and action-orientated training makes more sense and is more efficient than a merely subject-independant one. "Intelligent diagnostic teaching of any subject requires that judgments be integrated regarding both student characteristics and properties of the subject to be learned. ... In general, it will be insufficient to prepare teachers as diagnosticians and decision makers, per se; they must learn to match their strategies of judgment and prescription to the specific characteristics of the subject area in which they are working" (Shulman 1974).

In the framework of the minicourse programme there are a number of units with special reference to mathematics teaching (e.g. for problems of individualisation). The "Catalogue of Protocol Materials" of 1975, however, makes no mention so far of any units for mathematics. According to the "Master Coordinate Plan" (s. 3.5.) which monitors the development of protocol materials there are four general classes of concepts basic to the teaching process:

"1. Concept to be taught--from the conceptual structure of the subject

2. Concepts to teach with--from the conceptual foundations of the subject

3. Concept for professional understanding--from the humanistic and behavioral foundations of education

4. Concepts for skillfull teaching--from the humanistic and behavioral foundation for professional practice"

(Ph.G. Smith 1973, p. 29).

This list is remarkable for various things. The intention to represent audio-visually concepts from the subject content itself has so far been carried out only for the subjects language literature, reading and social sciences. This approach shares the problems of the "structure of the discipline"-concept as outlined above and it is certainly questionable whether practising a taxonomy of mathematical notions via their empiricistic representation is in any significant way favourable to the development of adequate strategies to deal with the content side of teaching. Rather, it seems highly remarkable that this introduces metaknowledge of the content (2. above) as the real subject leaving it open whether teaching isolated notions is suitable for the acquisition of this kind of knowledge. Some PM specialists seem to notice though that the concepts from the protocol materials themselves are in need of being placed within a complex theoretical framework if they are to contribute to "professional insight and understanding" (Ph. G. Smith 1973, p. 34).

Finally, it is striking that despite the explicit place content has found within the areas from which concepts are being chosen the classes of concepts mentioned under 3 and 4 show no reference to the subject matter. As usual, the content side is only considered in connection with the cognitive side of teaching, its consequences from a social and psychological point of view however remain untreated. In conjunction with corresponding procedures and models this can lead to teachers without an eye for the necessary mediation between cognitive, emotional and interactional aspects of teaching who then take rather narrow points of view which develop in many places through the established organization and concept of science as subject-specific processes of specialization and which gain an unchecked influence on the actual teaching itself. Concepts relevant for the didactics of a subject which refer to subject-orientated teaching strategies are once again a victim of the unfortunate separation of science of a subject and educational sciences.

It is clear that for more complex teaching strategies the dependance on the content is more prominent. Accordingly, more than a third of the teaching models listed by Joyce et al. (1972) cannot be used in all subjects. The "General Catalogue of Teaching Skills" edited by the Multi-State-Consortium on Performance-Based Teacher Education in 1973 starts by laying down the following objectives for the teaching of mathematics:

"1. To develop in the student an awareness of the nature of mathematics as a legitimate human endeavor.
2. To equip the student with the skills needed to implement

any career decision which is consistent with his or her interests and ability.

3. To develop problem solving ability" (Lester 1973, p. 8).

On the basis of these objectives individual skills are then specified and described within the framework of the three basic models of mathematics teaching, i.e. expository teaching, structured inquiry approach, unstructured inquiry approach. "... the focus is on identifying a core of skills which enables the teacher to pull together the underlying knowledge about students, goals, mathematics, and pedagogy and various external cues to make sound decisions about instruction" (Lester 1973, p. 9).

Here, too, the ambivalent relationship to the content aspect is quite apparent: on the one hand the prime objective of the training of teachers of mathematics is to be an "awareness of the nature of mathematics as a legitimate human endeavor, on the other hand the specification of the individual skills is based on models which are not subject-specific and therefore make it hardly possible to implement the suggested priorities. What needs to be done is to unfold the connections between the "perspective of teaching" and the "differentiated view of the content". Reduced concepts of content usually lead to reduced views of the variety of aspects of teaching and the teacher's role and conversely the concept of content influences and monitors the interdependance of the various dimensions of the teacher's acitivities. The difficulty here is that the various contents play a double role in the teaching/learning process in that they are objects as well as methods: concepts, theories and knowledge in general always represent objective and social implications at the same time as subjective and objective ones. Knowledge is of an anti-empiricist nature: Teaching of learning a concept is not comparable to the handing or taking over of an object. The teacher therefore must not only know the individual concepts (theories etc.) he wants to teach, but he must also know something about the nature of the scientific concept, i.e. nature of concepts as theoretical entities.

In his very influential book "Teachers for the Real World" (B.O. Smith 1969) which has run into many editions Smith makes a distinction between 'knowledge' and 'knowledge about knowledge' thereby marking probably the most conscious and influential expression of this problem. It is true though that Smith's concept of 'knowledge about knowledge' is full of eclectic ideas which have given rise to problematic and ambiguous developments.

Cooney et al. (1975a) explain Smith's approach as follows: "It is generally recognized that extensive knowledge of both subject matter and basic psychological principles applicable to classroom instruction are essential aspects of a teacher's knowledge base. What is not as readily recognized is the fact that there is another type of knowledge that is basic to effective instruction. As Smith (1969) puts it: 'It has only recently been recognized that there is another sort of knowledge that can influence the performance of the teacher: that used in thinking about the subject matter and the logical operations used in manipulating it'" (p. 125).

And Smith himself continues: "To handle the subject matter of instruction in certain difficult situations the teacher does well to understand its elements, its logical dimensions, its uses, its relation to pupil needs, and the degree of its social 'neutrality'. Because teachers do not now possess such understanding, they frequently handle the subject matter of instruction in superficial ways. Consequently, class discussion often suffers from undue vagueness and ambiguity, from unfounded and unchallenged claims, from a failure to develop the significance of the content" (B.O. Smith 1969, p. 126).

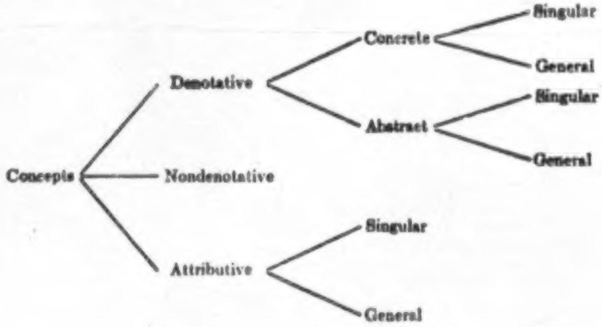
If they are to become part of educational programmes, 'knowledge' and 'knowledge about knowledge' must develop some kind of cohesive form. For Smith the borderline of the relationship between 'knowledge' and 'knowledge about knowledge' runs along the line of specific/general. "Knowledge about knowledge in general enables the teacher to gain this higher and more comprehensive perspective. This sort of knowledge is built upon more particular knowledge of the elements of subject matter and the relations among them, the uses of the disciplines' knowledge, and the way their information is manipulated and its dependability decided" (Smith 1969, p. 113).

To avoid the problem of the intersubjectivity of the meaning of empiric concepts this approach makes it seem natural to identify 'knowledge about knowledge' with the codifiable knowledge of formal logic. Correspondingly, Henderson who in the area of mathematics teaching has done a great deal of research and development work coordinated on the basis of Smith's approach (cf. Henderson 1970, Cooney/Henderson 1972, Cooney et al. 1975b) starts his explanations of a model of the acquisition of concepts by talking about the generally 'problematic' and difficult relationship of psychology and logic: "In the first case, a concept appears to be the set of associations a person has with the term that designates the concept. This point of view emphasizes the individualistic nature of a concept, but in so doing it loses theoretical power; it is not useful in a theory of teaching mathematics. Ordinarily, the mathematics teacher is concerned about a restricted set of associations which are supposed to be invariant as to concept-holders; he is not concerned with the emotional and attitudinal connotations of the designating expression" (Henderson 1970, p. 160). And consequently he defines 'concept' as follows: "It seems consistent with the foregoing to regard a verbal concept as an ordered pair, one component being a designatory expression, a name, and the other being one or more rules for using the designatory expression. (Some may wish to say 'meanings' rather than 'rules for using'. But meaning is not a well-defined term; one has only to consult an unabridged dictionary to realize its ambiguity.) Hence one component is in the metalanguage and the other in either the object language or the metalanguage, depending on its use" (Henderson 1970, p. 170).

The connections to the problem of meaning tend to remain implicit and underdeveloped in most educational theories or psychological theories of cognition. More developed approaches can be found in Ausubel's distinction between logic and psychological meaning or Piaget's designation or different deep structures in any empirical subject by the terms of 'psychological subject' versus 'epistemic subject' (cf. Beth/Piaget 1966, p. 308). Generally, the attempt is (including Henderson) to exclude the problems of meaning, because meanings are considered individual, theoretically useless, alogic, even 'unsocial', whereas the logical relations only are considered teachable and learnable as concepts and concepts as structures. This is the notion of concept in formal logic in which the concept has no intuitive, disparate nor genetic features. Of accordingly high importance are concepts of the 'structure of knowledge' in the sense given to it in formal logic; they represent as it were the backcloth on which learning happens. "Since one of the emphases of curriculum movements in mathematics and science in the last decade has been to produce materials which help students in seeing the overall structure of the subject matter rather than viewing the particular items of knowledge within the subject as ends in themselves, it behooves teachers to utilize teaching strategies which maximize the understandings of the interrelationships present in knowledge which are exhibited in these curriculum materials" (Cooney/Henderson 1972, p. 429/430).

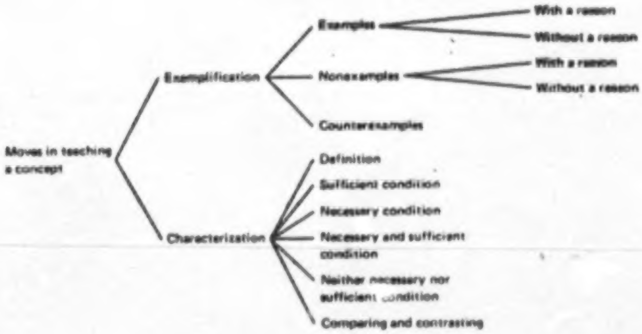
Nature and characterizations of formal logic are context-dependant and not absolute. Disputes on whether a problem is of an algorithmic or heuristic nature or whether logic is a means to acquire new knowledge or is only helpful to codify what one knows already are quite fruitless if carried on in isolation, in an 'absolute' framework and in an 'absolute' form. Consequently, logic cannot serve as a basis to the structure of knowledge and its objectivity (cf. Churchman 1973). Above all, however, there is no logic of operations or procedures of teaching and learning without a logic of the objects. Now one is justified to say that any 'logic', and formal logic in particular, has its roots in the interrelationship of 'logic of actions' and 'logic of objects': that is what makes its status as logic. In formal logic, however, this has taken a form which does not directly accommodate the development of the system of cognitive operations, the means and instruments of these operations, the aims and problems, the values and purposes. In teaching and also in science, there cannot be an equilibrium between cognitive activities and their content, between the aims, means and purposes in any static, fixed way, in the sense of, say, a superstructure a comprehensive, unified formulation of all the interrelationships from which one could then deduce a model of education. The concept, too, is not a structure 'as such': definitions and notions obviously reflect certain functional objectives, are context-dependant, just as the statements and interpretations of formal logic. H. Fehr (1966, p. 225) comments on this as follows: "A mathematical concept, even the most elementary or so-called basic one, is not a simple thing but a very complex entity. Similar to the structure of an atom which in its nuclear description becomes a more and more complex structure, the apparently simple idea 'cardinal number' becomes on investigation a multiplicity of ideas. Indeed a general concept of *number* is attained only by very few persons after many years of mathematical study."

The model by Cooney/Davies/Henderson as the only systematic attempt so far to make 'knowledge about knowledge' the central point of the education of mathematics teachers reduces these interrelationships and can therefore not sufficiently give justice to the importance of the new approach for the development of an adequate concept of content for the teacher. The idea of 'concept' on which this model is based is illustrated in the following diagram showing the classification of concepts:


Concepts
Denotative
Nondenotative
Attributive
Concrete
Abstract
Singular
General
Singular
General
Singular
General

(Henderson 1970, p. 176)

On the basis of this analysis and additional ones of various functions of scientific concepts individual steps, or 'moves', in the teaching of concepts are being identified and explained. Taken together, this results in the following typology which corresponds to the above concept classification system:


Moves in teaching a concept
Exemplification
Examples
With a reason
Without a reason
Nonexamples
With a reason
Without a reason
Counterexamples
Characterization
Definition
Sufficient condition
Necessary condition
Necessary and sufficient condition
Neither necessary nor sufficient condition
Comparing and contrasting

(Cooney et al. 1975, p. 107)

This typology fits in with the methodology originated by

B.O. Smith which tries "to develop a way of dividing verbal teaching behavior into pedagogically significant units, and to analyse the units in logically meaningful ways" (Smith/Meux 1970, p. 8).

The centre of interest for the authors is the exact description and identification of these 'moves' and their typology: the development of these 'moves' into strategies, the decision on the meaningful use of these 'moves' in learning sequences under special social and psychological conditions, these are aspects which receive only global treatment and which are dealt with in a few words. This, however, is where we are faced with one of the thorny problems of a teaching theory: how are the various 'bits and pieces' (in this case the 'moves') to be composed, under the given social, psychological and (mathematical) content conditions, into a kind of sequence which makes a continuous teaching process possible?

Cooney et al. give an example of a lesson on the acquisition of a concept which throws an interesting light on the underlying theoretical positions: "To illustrate the other kind of counterexample possible from a false definition, let us suppose a student states as a definition of an exponent that it is a number written to the right and slightly above another number that tells the number of times the number is taken as a factor. The following dialogue is conceivable:

T In 4^{-2}, is -2 an exponent?

S Yes.

T I agree that the -2 is written to the right and slightly above 4, but what does it mean to say that it tells us how many times 4 is taken as a factor? How can a number be taken as a factor -2 times?

S The exponent has to be positive.

T Ah, yes. Is 1/2 in $4^{1/2}$ an exponent? It's positive.

S Yes.

T Does 1/2 tell us how many times 4 is taken as a factor? What does it mean for a factor to be taken 1/2 times?

S Well, an exponent is a whole number written ... No, it's any number written to the right and slightly above another number.

T Is there an exponent in 4^4?

S Sure. 4.

T But you said 'to the right and slightly above another number', which seems to say the numbers are different. In 4^4 the two 4's are the same number.

S O.K. Slightly above and to the right of any number.

T Well, you're getting there. Is 0.5 in $\underline{a}^{0.5}$ an exponent? And how about $\underline{b}$ in $\underline{x}^{\underline{b}}$? Is $\underline{b}$ an exponent?

S Yeah. They're both exponents. O.K. Slightly above and to the right of any number or any variable.

T Just to be sure we've got it right, state the definition as it ought to be.

S An exponent is a number or a variable that is written to the right and slightly above any number or variable.

T I'll buy that" (p. 100/1).

Even if at the beginning the pupil still has a concept of the exponent which tells him something about its origin and function ("multiply as often as the exponent indicates") and which could serve as a basis to develop the complete concept from, in this learning sequence 'suitably' selected counter-examples drive him into a corner from where he has eventually no alternative but to give the required repetition of the purely formal definition of the concept: "An exponent is a number or a variable that is written to the right and slightly above any number or variable." - As if this definition could tell anyone anything about the content of the concept!

If there are a great number of combinable properties of concepts and therefore long 'move' sequence, one has to make a choice between a great number of different strategies. The development of such a strategy can be brought into an algorithmic system, because the concept as a given inventory of fixed elements and the process of change from the examples to an insight into the general value of a concept are thought to be 'linear processes'. Cooney et al. reduce the teaching process to the structural level, i.e. to the problem of 'transporting parts of a theory from the head of the teacher to that of the learner'. This idea is consistent with the belief that it is possible to make the process of teaching automatic: starting from a fixed, given structure a set of rules and procedures is developed which monitors the transmission and composition of the concepts in such a way that something like a copy of the existing mathematical structures is the result. However, with scientific concepts it is impossible to see at a glance and once for all how they are going to be constituted. Concepts have not been understood or learnt if their passing-on can be acknowledged through an enumeration of their properties. Without interpretation, without knowledge of the meaning of concepts and without reference to existing knowledge and existing mathematical theory the learner will be unable to make use of these mathematical structures. Just as the teacher himself must have 'knowledge about knowledge', i.e. in particular about the use, origin and development of knowledge, he can only help the learner to acquire new knowledge via the learner's previous knowledge, his system of activities, the socio-communicative and object-related world in which concepts are directly meaningful, comprehensible and interpretable for the pupil. The 'second kind of knowledge' must therefore inevitably include the reference to the previous knowledge of the pupil. The teaching process does not follow a direct immediate line from the given cognitive content structure to the one to be established.

Based on his understanding of content and the nature of mathematical concepts and under reference to the learning disposition of the pupil the teacher has to match 'content of concept' and 'activity system of the pupil'. This matching is 'problematic', i.e. it is not solvable once for all and cannot be made automatic. Openness of the systems of 'content' and 'acquisitive activity', their variability and the 'statistic nature' (cf. N. Wiener w.y., particularly p. 270/71) of their combination render the creation of a final definite teaching strategy impossible. The only way one can suggest of dealing with these problems is to keep using the teaching strategy concerned, in parts at least, as teaching content of a new strategy.

A similar suggestion has been made in the 'Concept Attainment Teaching Model' by Joyce/Weil (1972, p. 109-122). Here, three of the four phases of the model are concerned with strategies of concept acquisition, whereas one, the fourth, gives the pupil the role of the 'teacher' and makes him teach concepts to his fellow pupils. The strategies of this phase, too, are being turned into the content of teaching. To 'turn strategies into the content of teaching' does not mean, of course, that it is intended to train the pupil as teacher; this is already impossible from the content point of view, since there is no treatment of strategies as such, but only strategies and procedures of teaching as developed from the content and 'experienced'. It still remains the task of the teacher to structure this effectively as a teaching strategy where the aim remains the teaching and acquisition of concepts and where 'strategy for strategy's sake' is not going to be the necessarily formal teaching content. To 'make strategies the content of new strategies' is probably too difficult to be carried out in a constant change of methodic levels. It can only be our task here to show up how the teachers' metaknowledge about the meaning and function of contents can find expression in teaching strategies. This results at the same time in indications how to develop concepts of this metaknowledge further and how to integrate them in educational programmes so that they really penetrate and structure the acquisition of content rather than just formally reducing them to a common denominator.

6. *Conclusions*

It is with reservations only that it is possible from a survey of the research situation in the area of teacher education to arrive at further theoretical and practical consequences. This is particularly true for the practical consequences if the failure of empiric-rational strategies of innovation as described above is to be taken seriously. In what follows we are therefore not concerned with more or less directive pieces of advice, but with offers of discussion to potential future partners of cooperation. Much is in need here of greater precision and of correction through experiences and knowledge from other theoretical and practical contexts.

As the institutional and content conditions of a reform of teacher education in the Federal Republic has as yet been insufficiently disclosed by research and as this paper exclusively concentrates on working out a basic position on the basis of the present research situation, the external conditions have so far been neglected. At this point, however, where we are concerned with formulating suggestions as consequences of the results worked out so far, this practical and theoretical context must of course be taken into account if the suggestions are to be more than just a list of desiderata. In addition to the results of the apparently incomplete research literature therefore we have also tried to take into consideration the conclusions we arrived at through pilot interviews in relevant institutions of teacher education in various states of the Federal Republic. A summary of the results is given elsewhere in the documatation.

At the end of these introductory remarks there is the reservation that according to previous experience in educational reform research and development represent only one factor determining changes in contents, methods and forms of organization of the education system, and in view of the influences of educational politics and administration it is hardly the decisive one. The conditions for the implementation of the following suggestions offered for discussion to re-structure the training of mathematics teachers therefore go far beyond the range of activity and framework of cooperation of one research team.

The above situation, as background and precondition to any discussion of possible alternatives to the present practice and research in the training of teachers of mathematics in the Federal Republik, can be briefly characterised as follows: predominance of administrative innovation strategies and corresponding deficits in the field of curriculum development and in-service training of teachers; little influence of teachers' organizations on educational reform, particularly in the field of the curriculum; ambitious integration attempts failing because of the division and individual momentum of the disciplines and institutions to be combined, whereas institutional and content-concerned levels of mediation with restricted scope and limited tasks are lacking. All of this has to be seen on the background of a changing legal framework in the area of teacher education which is oriented towards the reduction of the length of studies and the continuation of the differences in the lenght and quality of the education of various groups of teachers according to different types and levels of schools. The corollary is a financial policy pressing for cuts and the re-consideration of expenditure and investments particularly in the field of education. It is well-known that public opinion too is no longer as favourable to educational reform as it used to be.

At the same time it becomes more and more apparent that the research preparing the ground for the implementation of reforms in teacher education is insufficient and that many practical and organisatory problems do not only necessitate new extensive research, but also a re-structuring of the conceptual basis and of the established system of division of work in science. "Der politische Frühling der Bildungsreformer zog so schnell vorbei, daß die Forschung nicht mitkam" (Luhmann 1974a, p. 16).

In connection with the justification from the point of view of innovation strategy for the increase in importance attached to teacher education in the context of the reform of the curriculum for mathematics it must be taken into account that the re-structuring of study courses within the institutional framework of university and 'Studienseminar' (training phase) poses serious problems of implementation and that this area as opposed to innovation at school level has so far hardly been covered by innovation research. Such a restructuring would need the cooperation of institutions whose forms of organization, predominant values and perspectives of reality are in certain respect extremely diverse and can therefore be reconciled with great difficulty only. It would for instance seem obvious to suppose a comparatively low degree of difficulty to arrive at a correspondence between the general educational components of the university course and the training phase. Nobody denies that this is necessary. One of the main complaints of those responsible for the training phase is indeed about the deficiencies of the educational component of the university course which forces the training phase to fulfil tasks which it is ill equipped to do and which keep it away from its proper job. On the other hand the problem has to do with agreements about identical or at least related contents and methods. However, in the institutional context of the university and of the training phase, the differences in the research relations of the educational sciences, in the organization of teaching, in the binding nature of course plans and in the administrative responsibilities under the present conditions are such as to make this agreement an apparently Sisyphean task.

Because of their marginal status it is easy for mediating levels with coordinating functions to be choked out of existence between various disciplines or between science and school realtiy or to be swallowed up by one of their more powerful partners. There is for instance an ardent dispute in the faculties about the institutional place of the didactics of a subject which would have to fulfil such a mediating function between the subject and the educational sciences although there is no clarity about the conceptual implications of a mediating function of that nature and the position of the didactics of a subject in teacher education (cf. West German Conference of Principals (WRK): Proposals for Teacher Education 1975) and although no corresponding emancipation of the didactics of a subject from the subject and from the educational sciences has to any great extent taken place. "In some sense, the organization reflects the way 'knowledge' is defined. A redefinition of knowledge (e.g. an interdisciplinary approach) will meet a number of constraining factors, many of them reflecting power barriers within the institution" (Dalin/McLaughlin 1975, p. 13).

All these points can only mean not to pitch one's hopes too high as to the next steps in the reform of the education of teachers of mathematics. Their institutional and administrative back-up will be rather inadequate.

From the organisatory side the aim can therefore only be to make use of the existing institutionalized channels of cooperation and communication and to establish a network of informal contacts between representatives of the various areas of experience concerned with the education of teachers of mathematics. If however these informal contacts between those concerned are to become productive, they must have a content basis as a precondition for the exchange of experiences and the development of common or coordinated concepts of problems.

It is not sufficient to merely coordinate the identification of shifts of topic areas and to create more efficient systems of information and communication, because this does not change the established state of knowledge and system of science in any way. For the development of content basis the most sensitive points in our opinion have to do with the relationship between theoretical education and practical training on the one hand and between the subject-related and educational aspect of the education on the other. For the first relationship the most promising startingpoints seems to us to be the use and the theoretical analysis of the various procedures of simulating practical situations as developed above all in the United States. The second relationship necessarily implies a reconsideration of the basis of the didactics of a subject. In the context of a theory of teaching this would have to account in particular for the institutionalized nature of teaching processes and it is against this background that it would have to analyse the interrelationship of social and subject-determined aspects of school work.

A basic reconsideration of this nature includes the development of a concept of general education which establishes connections between the contents and methods of a subject, the personal development of the child and the social function of the appropriate science. It is this alone that enables the teacher to relate consciously to problems of relevance, motivational difficulties, but also to the essential cooperation about content questions with colleagues from other subjects.

This raises of course also the question of possible aims and objectives. As in organised cooperative working processes objectives cannot be kept invariable and as this text can only be an introduction to working processes of this kind, the authors have adopted a certain reserve in this respect. Factors for the identification of aims would probably result from analyses of the effects of completed or nearly completed changes in teaching and schooling on the role and task of the teacher as they are being attempted, although non-subject-specifically, within the framework of OECD (cf. OECD 1974).

One of these factors would be the subjective disposition of teachers necessary for innovative behaviour (cf. Frech/Reichwein 1971; Frech 1972); in view of the stated lack of mediating institutions and of integration of the content of practice-related knowledge these dispositions gain additional importance. In this context, however, one would also have to consider the determining influence of schools as institutions to avoid asking too much of the personality of the teacher and to attribute to it what in fact has institutional reasons and is therefore only changeable on the institutional level.

A further factor which in our opinion has so far been rather underestimated would consist in the development of some subject-specific metaknowledge about the subject content which could enable people to keep a critical and conscious distance to reforms and at the same time to contribute actively to them. This could become a decisive link between the subject-related and the innovative or pedagogical and psychological qualifications, since it determines the contents within the social context and under reference to the personal development of the child. From the point of view of stabilising innovative subjective dispositions the importance of the recourse to the subject contents has also been noted in instances where the innovation process is basically seen as the individual enforcement of progressive attitudes resulting from experiences made during university studies. "Die von uns erarbeiteten Ergebnisse weisen darauf hin (wenn sie diese These auch nicht im strengen Sinne belegen), daß eventuell der Immunisierungseffekt, den ein kritisches Hochschulstudium gegenüber dem Anpassungsdruck der Berufspraxis besonders während des Referendariats haben kann, dann am größten ist, wenn innovative Haltungen sehr stark auch fachlich konkretisiert sind" (Frech 1974, p. 119/120).

In order to further clarify these ideas of objectives which we have intentionally left open, the following deductions concerning the passing-on of theory and practice in teacher education and concerning possible forms of the subject-related and the didactic components of a study course are put forward for discussion.

Individual integrative achievements and their support in teacher education are to receive by far more attention than they have been given so far in teacher education. For a practically efficient study course for teachers it is necessary for every student to evaluate and to integrate gained insights with a view to his behaviour in his own job. Teaching, more than any other activity, continually demands new achievements in the subjective reduction of complexities which even an optimally integrated kind of education can only prepare, but not entirely pre-structure.

This means that in the whole framework of theoretical and practical education procedures of a reflective nature are of great importance. They encompass all learning situations in which personal knowledge, personal attitudes, personal feelings and personal strategies of behaviour can be made conscious. This implies group dynamic arrangements as well as aids for the clarification of subjective processes of theory formation and of decision, the various kinds of behaviour training as well as the support of self-diagnosis and of the development of individual aim perspectives and learning strategies. The discrepancy between the superficial objectivity of the contents and the inevitability of permanent subjective (although not necessarily irrational) decisions during studies and later is particularly wide in the subject of mathematics; therefore reflective procedures should also be used in a subject-related way, e.g. within correspondingly structured learning sequences in the didactics of the subject.

Subjective interpretations of situations by the learner can change curricular intentions to the contrary also in teacher education. This is quite obvious for a central component particularly of the traditional two-phase education, viz. for the first contacts with practice during studies. Available international findings agree that the function of school practice is seen differently by students as opposed to lecturers or tutors. "At the moment school practice fulfils diffuse purposes and provides for wide but undifferentiated larning experiences. The result is that students have difficulties in realising and coming to terms with their school practice role. This is apparent from the amount of ambivalence and potential conflict revealed by student responses. ... Their value systems ... indicate that students place most importance on the opportunities practice provides for the adjustment of the self to the demands of the student teaching role" (Cope 1971, p. 107).

The important though ambivalent significance of this experience for the ability to cope with the 'practice shock' is continually being referred to. The variations developed within reform conceptions as for the re-structuring of the first contacts with practice are numerous (cf. Blickpunkt Hochschuldidaktik 35, p. 237 seq.) but as yet not sufficiently evaluated. The 'Empfehlungen zum Praxisbezug im Studium' (Herz et al. 1975, p. 64) say in this context: "Die hitzig geführten aber unabschließbaren Diskussionen, welche der alternativen Intentionen und Formen besser oder gar einzig richtig sei, wären vielleicht überflüssig, wenn es eine Sequenz funktional verschiedener Praxisphasen und -erfahrungen im Studium gäbe." To agree with this view does not yet mean to be in possession of an adequate concept of differentiating the functions. However, the following separation of three different functions suggests itself: adaptation to a new social context while reducing as far as possible additional subjective stress, systematic exploration of the social context 'school' (pre-structured through theoretical knowledge and specific observations), the trying-out of professional competencies in teaching.

For the last point the procedures for connecting theory and practice referred to in part 3 would be of particular value and would at the same time offer the possibility of additional function-specific differentiations under the aspects of strategy formation, skill development, development of psycho-social competence etc. Parallel to growing experience with individual functions the degree of differentiation can be gradually reduced and the complexity to be coped with be increased. It is indeed the great advantage of reflective procedures to develop selection and complexity in a systematic and conscious way. This means that theoretical knowledge becomes easily connectable and that experience with practice is developed which shows reality as consciously controllable and not so unstructured as to leave adaptation as the only possible reaction.

The closer identifications of the problem of theory versus practice which in America have led to a pragmatic restriction to teaching in the narrower sense provide at the same time the possibility to define more closely their relationship to the teaching contents. The respective evaluation of the various procedures as attempted in chapter 5 yields two main results. First, by focussing on skills, concepts, and models of teaching certain conceptual deficits in the concept of content in these procedures become more apparent and are at the same time more specifically identifiable. During the development of Protocol Materials for instance this became obvious in connection with the difficulties resulting from the individual characteristics of didactic as opposed to subject-specific or educational concepts. Secondly, just because of their dual, i.e. descriptive and prescriptive, function many of these procedures represent a compromise between the passing-on of general educational information and the unsystematic approach to accidental practical occurrences. They therefore offer more systematic and concrete orientations for didactics than the fast-changing 'fashions' in the educational sciences or than practice entirely based on 'craft traditions'. In this respect these procedures if used widely and accompained by corresponding progressive developments could become integrative elements between theory and practice in teacher education and could provide important impulses for a re-definition of the basis of the didactics of a subject.

It is changes in the subject and methods courses within training which in our opinion provide the most hopeful prospects although it is precisely the field of didactics which has the greatest need for development.

The specific difficulties of integrative attempts in teacher education which are the result of the previously discussed dual nature of theory in its relationship to practical teaching are bound to increase in future, since on the one hand more emphasis is to be given to the subject reference of teacher studies while on the other the educational and sociological components are to be extended and re-structured. In all probability the respective disciplines and components will develop still further away from each other while the didactic of the subject are at present too feeble as integrative force to be able to counteract this trend.

Capacity problems at university level encourage the tendency of established disciplines to look after, and keep to, themselves and with this they contribute to the desintegration and reduction of didactics. It is no surprise therefore that at present the didactics of a subject are supported neither by a developed system of educating their own future personnel nor by a developed and sufficiently documented teaching tradition. Emancipation from the concepts, approaches and kinds of teaching of the corresponding science has been slow; it is still true that nearly in all Colleges the subject-related component in the education of future teachers of mathematics is taken care of by people primarily concerned with didactics and that the more theoretical aspects of didactics are hardly reflected in the teaching at our Colleges (cf. Bauersfeld et al. 1971, p. 111). Lack of material and equipment is often the cause of provincialism in work on didactic problems. The construction of content-oriented courses at school level has been very much the centre of interest of those concerned with didactics, whereas basic problems and problems of dissemination are much less prominent and have often been considered untreatable even where they have aroused interest (cf. Bauersfeld et al. 1971).

There is a wide gap between the objective demands on the didactics of mathematics as an integrative discipline of teacher education and the present state of its conceptual and organisatory development. This can only be overcome, and its key position in the framework of teacher education been done justice to, by increasing the theoretical demands towards it and by confronting it with more ambitious tasks. It is in this sense that the following remarks about the subject studies of a teacher are to be understood.

We start from the assumption that every teacher needs wellfounded studies in the subject itself. There are indications that teachers of mathematics with a more thorough mathematical education are more flexible and open in their teaching behaviour when dealing with materials as well as when interacting with pupils. What is not clear so far though are the problems of which kind of mathematics teachers should know, how far advanced they should be in individual mathematical disciplines and what degree of specialization would be desirable (Begle 1972).

We consider it neither possible nor useful to look at the mathematical studies of future teachers entirely from the perspective of their future profession, e.g. in the sense of a curriculum instruction or a mathematically enriched version of 'elementary mathematics from a higher point of view'. An education focussing extremely narrowly on later professional activities would not do justice to the characteristics of the scientific disciplines (B.O. Smith 1969, p. 114) and would leave the teacher with a rather distorted view of mathematics. In addition, the unsecure professional perspectives of teachers make separate study courses for teachers have little to recommend themselves. Instead, a high degree of flexibility in keeping the options open between all kinds of study courses should be aimed at.

We do maintain though that the teacher of mathematics, as opposed to the future scientist or mathematician in industry, should receive a relatively broad mathematical education extending over a range of mathematical disciplines. The teacher - much more than for instance a research specialist - needs a comparatively broadly based mathematical education; on the one hand because of objective professional demands, on the other because the faculty to open up entirely new content areas in one's future professional life cannot be rated very highly.

The time available for the subject component proper of the study course is severely limited. It seems sensible to try to meet the resulting problems by instituting, for the subject studies of prospective teachers, a series of additional special courses with a different, e.g. application- or method-related, orientation. "Analysis of Algorithms" (D. Knuth 1968) would for instance be an appropriate topic in this context. Above all, however, the greater differentiation of the mathematical studies of prospective teachers is supported by the fact that mathematical knowledge plays a different role in the activity of the teacher than in that of the mathematician in industry or research: "Nevertheless, it is impossible to disregard the complicated relation between academic disciplines and subject courses at general education schools. Modern natural and social science disciplines from which subject courses in secondary schools are constituted are highly specialized and represent dynamic research which very rapidly changes its standpoints and methods. At the same time from the point of view of pure research the relation of knowledge in natural and social science to man is not relevant. This relation is however important if a secondary school subject course created from a number of partial disciplines is to fulfil its educational purpose. This fact also should be taken into consideration in courses in academic disciplines for prospective teachers whose preparation should, at least in some of its components, differ from that of researchers - a differentiation which should take place particularly at the end of the period of study.

It seems that this solution has a certain hope of success, while extreme orientation of content and organization of academic disciplines toward the teaching profession is unacceptable to the university" (Kotasek 1972, p. 118).

It will be necessary to introduce a second level, a kind of meta-level, as part of the study course. There, the aim would be to gain 'knowledge about knowledge' as basis of an introduction to the professional use of knowledge. This 'knowledge about knowledge' would encompass first of all knowledge of methodology and theory of science, secondly of the history of science, and third, knowledge of the relationship of mathematics to other subjects.

Aspects of methodology and theory of science could initially be treated on an explicitly theoretical level; topics e.g. 'Mathematical Abstraction and Experience', 'Methods and Structures of Mathematics', 'Problems of Application', 'Mathematical Sciences and Teaching' (cf. in this context e.g. Weyl 1966 and Otte 1974b). Parallel to this there is the possibility of personal learning strategies being made conscious and developed while dealing with scientific topics. Here, a special kind of anticipation of later professional activities suggests itself: whoever, as a student, has consciously followed his own learning process in mathematics also in view of the relationship to various teaching methods will have less difficulty in changing over to the role of the teacher who must obviously keep an eye on both sides of the teaching/learning process. The so-called principle of congruence (van Dormolen 1974, Springer 1973) attempts to provide a systematic foundation for this connection.

Finally, the methodological aspect can also find expression in practising special working procedures; a period of practice in 'information processing' could for instance provide explicit criteria about how to approach a mathematical monograph, an entry in a work of reference, a course book. Some of this can be realized within the framework of the traditional seminars if these are provided with a more method-conscious basis. "... in the conventional lecture course it is the teacher who is responsible for collecting and preparing the material. He it is who irons out conflicting pieces of evidence, and evaluates alternative presentations. He, the teacher, learns as a result - we all know that the best way to learn a subject is to give a course of lectures on it. Yet students are traditionally denied such opportunities for learning" (Howson 1975, p. 22 seq.).

If pieces of methodological information are presented in too high a degree of 'isolation and purity', instead of being organisatory elements they can turn into hindrances pre-structuring too narrowly the learning capacity and cognitive activity in a formal sense in relation to the subject and contents. "Wenn methodologische Fragen einzeln herausgestellt werden, erweisen sie sich für den Unterricht als ein äußerliches Wissenssystem und beeinflussen das Verständnis und die Aneignung der Inhalte im System nur unwesentlich, d.h. das Ziel, dessentwegen sie eingeführt werden, wird nicht erreicht. Werden methodologische Kenntnisse nur in das Material hineingearbeitet vorgetragen, gewinnen Schüler keine ganzheitlichen Vorstellungen über die Methoden der wissenschaftlichen Erkenntnis ... daher ist es zweckmäßig, methodologische Kenntnisse überwiegend in das Sachmaterial einzubauen, sie dabei aber einzeln herauszustellen" (Zorina 1975).

It is our experience, too, that a "two track approach' is necessary. Methodological knowledge has to a certain extent to be presented explicitly in advance, since in teaching one has to work right from the start with general scientific terms ('definition', 'concept', 'method' etc.) whose structure and meaning should at least roughly be familiar. Billeh et al. (1975) report on an empiric experiment in conjunction with a summer course for science teachers comprising the following topics: "What is science?; Science and common sense; science and technology; art of scientific investigation; nature of scientific knowledge (characteristics, classification, scientific theories, and models); growth and development of scientific knowledge; and sociological aspects of science" (Billeh/Hassan 1975, p. 211) emphasising that "... the major component of the training course that has contributed to the gain in teachers' understanding of the nature of science was the formal instruction in the nature and structure of science" (Billeh/Hassan 1975, p. 216; similarly Carey et al. 1970). To redress the balance it must be pointed out that methodological information necessarily has a partly formal status and should therefore as far as possible always come into its own a second time as generalization of experience gained from actual contacts with the subject matter itself.

Historic aspects of science should form an integral part of the studies of teachers to pass on at least some elementary knowledge about the dynamics of concept development, of the specific nature of mathematical matters and an understanding of interdependance of the history of mathematics and social development. A systematic justification can be found in Otte (1974a); an adequate description of the problems connected with the incorporation of historic aspects is given in Howson (1975): "Yet teaching the history of mathematics presents a great challenge. It is very easy for it do degenerate into a collection of anecdotes, ...".

An example of what an adequate conception of teachers' studies could look like can be taken from a publication by Lakatos (1963). As regards the state of development in view of the actual incorporation of aspects of the history of science the following statement by Howson (1975, p. 21) is probably representative also for other countries: "In England it is not usual to offer a course on the history of mathematics within the framework of the undergraduate course. Indeed, I believe, that Southampton is now unique in presenting such a course and in permitting the student's work in it to affect his degree classification."

Knowledge about the relationship between mathematics and other school subjects belongs to the essential amount of knowledge of prospective teachers. The treatment of applicational problems of mathematics presupposes already some minimal knowledge of other subjects, and this is even more so for complex objectives such as 'multidisciplinary teaching'. Knowledge of this kind can be acquired within the framework of special courses, e.g. on the theory of science, but also by studying a second subject. Usually, studies in two subjects are recommended for school organisatory reasons (e.g. in Kotasek 1972, p. 199; or in the National Council of Teachers of Mathematics, 14th Yearbook 1966). However, there are also internal reasons for studies in a second subject: Certain multidisciplinary qualifications can be gained most economically or perhaps even exclusively on a comparative basis. In its most radical form this insight leads to the demand (OECD 1972, p. 234): "It is necessary for the future teachers to get the feel and practice of pluridisciplinarity right away."

The demand for studies in two subjects for teachers of mathematics does not necessarily imply that the second subject must be one of the natural sciences. On the contrary, to develop a realistic view of the possibilities and limitations of mathematics and in order to keep a reciprocal check on one-sided views as encouraged by subject-specific studies it is in particular the combination with a subject from the social sciences which offers excellent possibilities. Since there is not doubt that the teacher is faced with enormous problems of integration in the cognitive field, problems of the relationships between the various disciplines of the natural and the social sciences are deservedly of interest for teacher education. It is well conceivable that the cooperation between teachers of different school subjects later in everyday school teaching is as highly important as the so far underdeveloped though essential cooperation and communication between the teachers of mathematics themselves.

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